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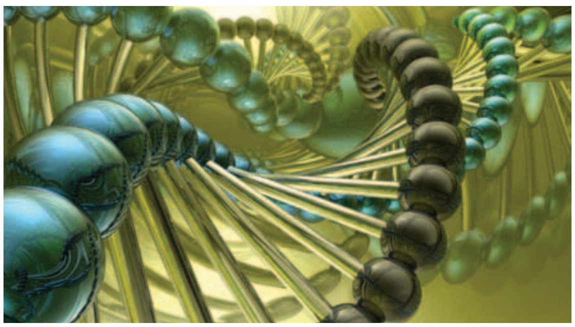

MAY 2009

THE GREATER PHILADELPHIA LIFE SCIENCES CLUSTER 2009

An Economic and Comparative Assessment

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Executive Summary

Breakthroughs in the life sciences are changing the way we live and work. Advances in understanding of diseases, personalized medicine, stem-cell research, and many other areas promise major transformations by developing new therapies and modernizing the way health care is delivered.

Cutting-edge R&D, high-tech manufacturing, and medical services are not only providing new treatments; they're creating millions of high-paying jobs along the way. As economic activity is increasingly based on intangible assets, life sciences clusters at the leading edge of innovation will exhibit more rapid growth—and will be less likely to see the benefits escape to other regions.

The growth of Greater Philadelphia's life sciences cluster is primarily the result of its position as a major center for the U.S. pharmaceutical industry and its strong local research infrastructure, which includes some of the nation's top-ranked universities. The region's eclectic mix of university research, world-renowned teaching hospitals, technology spin-out companies, and other startups—all interacting in a network—encourages companies to establish operations and grow in Greater Philadelphia. Underpinning all this interconnected activity is an evolving support network for entrepreneurs, including venture capitalists, high-tech absorptive capacity, and providers of professional services.

Our analysis measures the relative strength of Greater Philadelphia's life sciences cluster, comparing its performance to that of other leading metro areas around the country. Among our findings:

- Greater Philadelphia moves up to 2nd place in the Overall Composite Index with a score of 97.7, up from its 3rd-place ranking in our 2005 analysis.
- Greater Philadelphia claims the top spot in our Current Impact Composite Index, increasing its lead over Greater New York to 7 points, after holding a slim lead of only 0.3 point in 2005.
- In the Innovation Pipeline Index, Greater Philadelphia remained in 3rd place, maintaining its 2005 ranking but largely closing the gap with 2nd-ranked Greater San Francisco.
- Greater Philadelphia's weakest performance was in the Small Business Vitality Index, where it placed 9th overall.
- After accounting for the ripple effects, the life sciences sector in Greater Philadelphia was responsible for generating 380,800 jobs, $20.2 billion in earnings, and $39.7 billion in output in 2007.
- Fifteen percent of all economic activity and one out of every six jobs in Greater Philadelphia can be traced back to the life sciences.
- Greater Philadelphia is a vibrant life sciences cluster with many advantages that can be further exploited to spur continued growth.

In this study, we revise and extend our original 2005 analysis of the Greater Philadelphia life sciences cluster relative to ten other leading clusters in the United States. We begin by benchmarking where Greater Philadelphia stands in the current continuum. We analyze its ability to innovate, commercialize research, and sustain long-term competitiveness. We demonstrate the multiple economic contributions of the sector by calculating the direct, supply chain, and total ripple effects of the life sciences in Greater Philadelphia. In this updated study, we have added a new Small Business Vitality Index that evaluates the success of each metro area in creating new entrepreneurial firms, which constitute the lifeblood of cluster sustainability. Lastly, we highlight case studies of firms that are illustrative of corporate social responsibility efforts in the region.

Current Impact Assessment

The Current Impact section analyzes the economic impact and growth of the life sciences industry in the Greater Philadelphia area, while offering a similar benchmarking assessment for ten other leading metropolitan regions.

The life sciences encompass six major industries: pharmaceuticals, biotechnology, life sciences R&D, medical devices, health-care services, and supporting industries. The following four categories fall under the umbrella of **therapeutics and devices**:

- pharmaceuticals
- medical devices
- biotechnology
- R&D in the life sciences

We also measure the **health-care services industry** and the **life science–supporting industries,** since the growth of a cluster is fueled by its interaction with a metro's hospitals, medical practitioners, and other fast-growing, knowledge-intensive industries related to the sector. Health-care-related industries (including medical laboratories and diagnostic imaging centers) bolster the growth of life sciences clusters. We analyze each industry using seven measurements, which together comprise the results of the Current Impact Composite Index:

- employment level in 2007
- location quotient (LQ)[1] in terms of employment in 2007
- relative employment growth from 2002 to 2007
- number of establishments in 2007
- number of life sciences industries with location quotients greater than 2.0
- number of life sciences industries with location quotients less than 0.5
- number of life sciences industries growing faster than their U.S. counterparts from 2002 to 2007

Greater Philadelphia claims the top spot in our Current Impact Composite Index, followed closely by Greater New York and Boston (Boston has moved from 4th place in our 2005 study to take 3rd place). While the previous study saw Greater Philadelphia beating out Greater New York by only 0.3 index point, that lead has increased to 7.0 index points.

Greater Philadelphia has maintained its dominant position in pharmaceuticals, but its strengthened position in Current Impact is attributable to advances in biotechnology R&D (which boosted its position to 1st in therapeutics and devices from 3rd in our 2005 study) and continued top-tier performance in health-care services and life science–supporting industries. Improved access to pre-seed, seed, and early-stage risk capital is helping to elevate its status in biotechnology.

1. The location quotient is an index for comparing a metro's share of employment in a particular industry relative to that of the national share. A metro with a location quotient greater than 1.0 has a higher concentration of life sciences employment relative to the United States as a whole.

Current Impact Composite Index
2007

Rank	Metro area	Therapeutics and devices	Supporting industries	Health-care industries	Composite score
1	Greater Philadelphia	100	100	81	100
2	Greater New York	88	76	100	93
3	Boston	99	67	61	91
4	Greater San Francisco	86	74	49	81
5	Greater Raleigh-Durham	88	63	44	80
6	Greater Los Angeles	82	67	61	79
7	Chicago	79	67	58	76
8	Minneapolis	77	71	42	72
9	San Diego	74	51	36	67
10	Washington, D.C.	62	39	68	63
11	Seattle	55	31	50	54

Innovation Pipeline

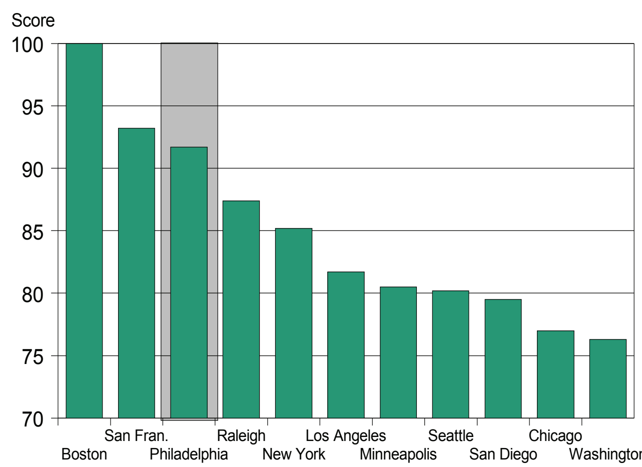
A vibrant and competitive life sciences industry must be supported by a strong and efficient innovation pipeline composed of economic elements that facilitate the industry's technological advances and production. We analyzed the innovation pipeline of Greater Philadelphia with a view toward determining its capacities to generate and commercialize ideas, research, and health advances relative to other leading centers.

As in our previous study on Greater Philadelphia's life sciences cluster, the innovation pipeline consists of five components:[2]

- research and development (R&D) capacity
- risk capital and entrepreneurial infrastructure
- human capital
- workforce
- innovation output

The results of the Innovation Pipeline Composite Index show that Greater Philadelphia retained its 2005 rank of 3rd place, just behind Boston and San Francisco. It is notable, however, that Greater Philadelphia largely closed the gap that previously existed with 2nd-place San Francisco. Remarkably, Greater Philadelphia has sprung into the top percentile in this study, in contrast to the results of our 2005 analysis, in which only Boston and San Francisco posted scores above 90 points.

Innovation Pipeline Composite Index
Selected metropolitan regions, 2009



Source: Milken Institute.

2. Ross DeVol, et al., *The Greater Philadelphia Life Sciences Cluster* (Milken Institute, 2005).

The foundation for Greater Philadelphia's performance is firmly established in four of the five components. With the exception of research and development capacity, Greater Philadelphia performed substantially better than the eleven-metro average. It is especially noteworthy that Greater Philadelphia jumped to 1st place in human capital, beating out the historical leader, Boston. Its world-class universities also lay the foundation to attract venture capital, supporting its jump in the index.

Two related components—innovation output and workforce—stem directly from Greater Philadelphia's knowledge base and assets. With improved venture capital support and leading universities specializing in the life sciences, it is not surprising to see the region excel in innovation output and life sciences workforce.

Although Greater Philadelphia did not perform as well in R&D capacity, its strength in the other components enabled the region's innovation pipeline to maintain a solid ranking. Increasing its R&D capacity is an opportunity for the region to leverage its strengths in other areas to boost the overall effectiveness of its innovation pipeline.

Small Business Vitality

The Small Business Vitality Index evaluates how successful regions are in creating new entrepreneurial firms, which are the lifeblood of cluster sustainability. Small firms often embody entrepreneurial values and cutting-edge ideas. The underlying importance of entrepreneurship can be illustrated by the value attributed to it by governments in different regions around the world. Engagement of entrepreneurs and small firms in supporting philanthropic and charitable activities can greatly support a community as well.

Entrepreneurs represent innovation and thus trigger heightened competition and higher expectations in a market.[3] Entrepreneurial endeavors are a particularly critical element in the Greater Philadelphia area, given its dependence on the cutting-edge research and innovations of the life sciences industry. Our analysis focuses on small firms that have fewer than twenty employees in our comparisons.

Juxtaposed against the other ten leading metros, Greater Philadelphia showed moderate strength in the performance of its small life sciences firms. Despite strengths in its pharmaceutical industry, small firms in the therapeutics and devices field in the region showed only modest growth of 21 percent between 2002 and 2007. Greater Philadelphia placed 9th overall in Small Business Vitality. It has yet to develop the entrepreneurial sophistication of such places as Greater San Francisco, San Diego, Boston, Greater Los Angeles, or Greater Raleigh-Durham.

Multiplier Impacts

The life sciences sector in Greater Philadelphia provides significant value to local residents and an enormous amount of wealth to the region overall. Its economic contribution to the region goes well beyond simply **direct** impacts, which include the jobs it generates, the earnings it provides to workers, and the output it creates. In order to capture the full contribution of the economic impacts stemming from the industry and its location, we apply unique coefficients, known as "multipliers," to the specific life sciences industries.[4]

The extent of such an impact is typically determined by analyzing the length and characteristics of the supply chain throughout the region. Pharmaceutical and biotech manufacturing has one of the highest employment multipliers in the region and is high across the country. Supplier industries, outside contractors, and other

3. Benjamin Yeo, *Developing a Sustainable Knowledge Economy. The Influence of Contextual Factors* (Germany: VDM Verlag, 2009).
4. Through their RIMS II program, the Bureau of Economic Analysis (BEA) assigns multiplicative values to regional industries.

businesses catering directly to the life sciences are part of this tightly knit network. Their presence is a key part of the industry's **indirect** impacts. The supply chain activity generates yet more income for the region's residents, who in turn recycle it back into the economy. These consumption effects are termed **induced** economic impacts.

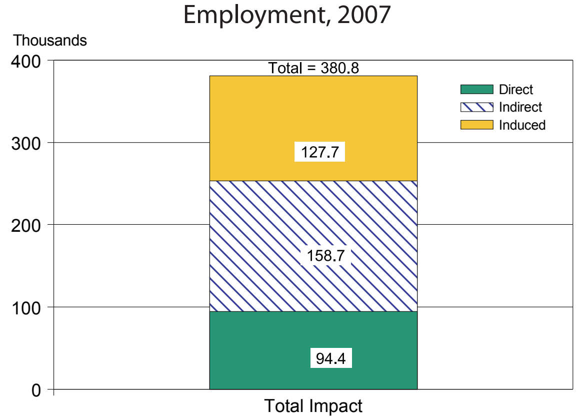
In 2007, the life sciences sector in Greater Philadelphia employed 94,400 workers, including those who provide health-care services consumed by non-residents. Out of that total, nearly 60 percent (or 56,300 jobs) stem from therapeutics and devices. The remaining 40 percent consist of health-care service jobs that were generated through export-driven activity outside the region. In determining the portion of health-care services *not* consumed locally,[5] we examine the relevant location quotients from our current impact assessment.

The region's life sciences sector generated $7.7 billion in earnings and $17.5 billion in output or gross metro product (GMP) in 2007. In both cases, the therapeutics and devices segment accounts for the largest share of the earnings and output created by the overall life sciences sector.

After accounting for the multiplier impacts, the life sciences sector in Greater Philadelphia is responsible for 380,800 jobs, $20.2 billion in earnings, and $39.7 billion in output based upon 2007 information. In other words, the life sciences both directly and indirectly drive roughly 15 percent of all economic activity in the region. Furthermore, one out of every six jobs in Greater Philadelphia can be traced back to the life sciences.

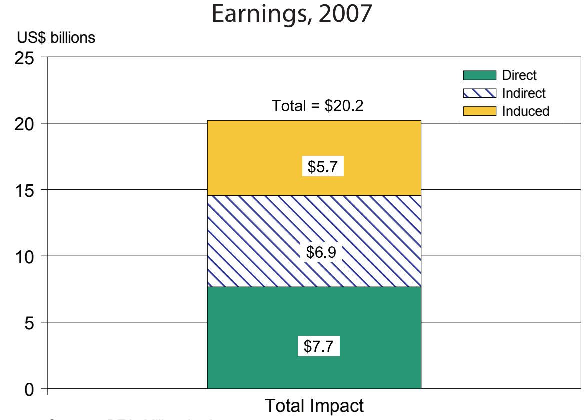
The chart below on the left explains the breakdown of the total life sciences impacts in Greater Philadelphia once the multiplicative dynamics have been taken into account. On top of direct employment, an additional 286,400 total jobs are generated as a result of life sciences; 158,700 are created indirectly and another 127,700 arise from induced impacts. In other words, for every job created in the region's life sciences sector, three additional jobs are created elsewhere. Similarly, in terms of earnings, an additional $12.6 billion dollars is created after filtering through other sectors.

Total impact of Greater Philadelphia life sciences
Employment, 2007



Sources: BEA, Milken Institute.

Total impact of Greater Philadelphia life sciences
Earnings, 2007



Sources: BEA, Milken Institute.

5. The existence of therapeutics and devices alone creates economic activity throughout the health-care services sector that would be consumed locally. Therefore, applying the multiplier to therapeutics and devices would result in jobs, earnings, and output created in health-care services. However, it would not account for the incremental activity brought on by demand from outside the region. To do this, we take the location quotient for the relevant health-care industries. If the LQ exceeds 1.0 for any given health-care industry in the region, we calculate only the portion that exceeds the national average. If we were to apply the entire health-care service employment in the region to its respective multiplier, we would be effectively double-counting.

Overall Composite Index

Our Overall Composite Index of the life sciences provides a single comprehensive measure of how Greater Philadelphia is positioned against the elite clusters in the United States. We utilize the Current Impact, the Innovation Pipeline and the Small Business Vitality indices created in our earlier detailed assessment to arrive at an overall result. This combination produces a powerful assessment tool in analyzing how life sciences clusters compare.

Greater Philadelphia moves up to 2nd place in the Overall Composite Index with a score of 97.7, up from its 3rd-place finish in our 2005 analysis. It achieved this, in part, by increasing its 1st-place advantage in the Current Impact Assessment to 7.0 index points, from a margin of just 0.3 in 2005. Despite remaining in 3rd place in the Innovation Pipeline Index, Greater Philadelphia largely closed the gap with 2nd-place Greater San Francisco. Once lagging 4.4 points behind, Greater Philadelphia is now only 1.5 points behind in this year's analysis. Its weakest performance was in Small Business Vitality. Among establishments with twenty or fewer employees, it came in at only 9th place.

Overall Composite Index for Life Sciences

Rank	Metro area	Current Impact	Innovation Pipeline	Small Business Vitality	Overall Composite Index score
1	Boston	91.3	100.0	87.4	100.0
2	Greater Philadelphia	100.0	91.7	63.9	97.7
3	Greater San Francisco	80.7	93.2	91.1	92.1
4	Greater New York	92.7	85.2	72.2	92.0
5	Greater Raleigh-Durham	79.7	87.4	85.0	88.2
6	Greater Los Angeles	79.0	81.7	100.0	86.8
7	Chicago	76.4	77.0	69.5	80.1
8	San Diego	66.9	79.5	87.4	78.7
9	Minneapolis	72.2	80.5	54.3	78.2
10	Washington, D.C.	63.3	76.3	80.5	74.8
11	Seattle	53.5	80.2	54.5	69.2
	Weights	0.45	0.45	0.10	

Conclusion

Greater Philadelphia is a vibrant life sciences cluster with many distinct advantages. Boston remains in 1st place in our overall results, but it now leads by a slimmer margin. Boston has higher concentrations of medical devices and biotechnology than Greater Philadelphia, which has its historical roots in the pharmaceutical industry. Boston's leading universities are scientific research stalwarts with a long history of active participation in the commercialization ecosystem. University-based startups in Greater Philadelphia are just above the eleven-metro average, indicating that its extensive strengths in research have yet to be fully captured in the region's economy.

While it is closing the risk capital gap with Boston and Greater San Francisco, Greater Philadelphia does not have the extensive network of collaborating agents in place that these other metros have developed. Greater Philadelphia has been able to offset this disadvantage with massive amounts of industry R&D in the life sciences, principally at its pharmaceutical firms.

A broader view of the future direction of the life sciences in Greater Philadelphia reveals both challenges and opportunities. It is a reality that market forces are causing consolidation in the pharmaceutical industry, and many jobs will be eliminated in the process. On the other hand, if its rich human capital base can be quickly redeployed—by attracting biotech firms, starting more of its own, and growing them to maturity—Greater Philadelphia could evolve to become the top life sciences cluster in the world. Enhanced research collaboration between biotech and pharmaceutical firms, leveraging the pharmaceutical industry's knowledge of stewarding compounds through FDA clinical trials procedures, along with the excellent clinical trials management capabilities resident in the region, provides Greater Philadelphia a unique opportunity for future growth.

Introduction

To define Greater Philadelphia's opportunities and challenges in the life sciences, BioAdvance, Select Greater Philadelphia, DelawareBio, BioNJ, Pennsylvania Bio, PhRMA, PricewaterhouseCoopers, and the Greater Philadelphia Life Sciences Congress have come together to seek solutions by assessing, analyzing, and benchmarking its current position.

The Milken Institute is pleased to update and extend our 2005 study in order provide a comprehensive mechanism for evaluation. The ultimate objective is to provide a springboard for developing an overarching long-term strategy for maintaining and growing Greater Philadelphia's life sciences industry. This strategy is intended to fuel further development and expansion of the life sciences that will help support sustainable economic prosperity in the region.

To achieve this goal, we undertook the following research approach:

Identify key industry specializations in the life sciences. In our benchmarking analysis of each of the six life sciences industry groups, we identify Greater Philadelphia's major strengths. We line up the economic bases of each life sciences industry group by region to establish Greater Philadelphia's relative position.

Identify significant assets in the life sciences. In order to create sustainability, the life sciences industry must be facilitated by a virtuous cycle of technological innovation. To identify crucial industry specializations, we take a closer look at the life sciences innovation pipeline in Greater Philadelphia to identify those assets the region can leverage for sustainable growth.

Determine the broader economic impact of Greater Philadelphia's life sciences industry. The effect of the life sciences industry ripples through its regional economy. We calculate the employment, earnings, and output created in other industries in the form of direct and indirect economic impact stemming from the life sciences.

Assess the growth of life sciences establishments in Greater Philadelphia. Small establishments, including those not typically captured by payroll databases, are important indicators of the dynamism and vibrancy of an industry. Using time series data, we assess the behavior of these establishments in Greater Philadelphia, thereby drawing conclusions about the region's entrepreneurial capacity in the life sciences.

To provide some qualitative background, we discuss life sciences companies engaging in corporate social responsibility (CSR), which includes community outreach programs and public contributions. Companies engaging in CSR generally consider the larger interest of the community and region in addition to immediate gains. Within Greater Philadelphia are communities that vary greatly in socioeconomic status and needs. These acts of CSR directly address these communities, and in the process, facilitate benefits to the region's life sciences industry in the long term.

We bring all of the above-mentioned elements together by creating an Overall Composite Index, providing a single comprehensive measure of how Greater Philadelphia is positioned against the elite life sciences clusters in the United States. This combination produces a powerful assessment tool for analyzing how life sciences clusters compare and where their competitive advantages lie.

Current Impact Assessment

This section analyzes the economic impact and growth of the life sciences in the Greater Philadelphia area, while offering a similar benchmarking assessment for ten other leading metropolitan regions. This examination allows us to compare each metro's industry performance against that of its cluster peers. The regions best positioned to achieve sustainable growth in the life sciences industry are those with pools of talented researchers, innovators, and experienced professionals, combined with the presence of a number of major research universities and hospitals as well as access to venture capital firms.

Industry Definitions

The life sciences encompass six major industries: pharmaceuticals, biotechnology, life sciences R&D, medical devices, health-care services, and supporting industries. The following four categories fall under the umbrella of **therapeutics and devices**:

- pharmaceuticals
- medical devices
- biotechnology
- R&D in the life sciences

We used the North American Industry Classification System (NAICS) to go further in defining these categories. According to the 2007 NAICS, therapeutics and devices includes a total of twelve industries at the six-digit NAICS level.

We also measured the **health-care services industry** and the **life science–supporting industries,** since the growth of a life sciences cluster is fueled by its interaction with a metro's hospitals, medical practitioners, and other fast-growing, knowledge-intensive industries related to the sector. Health-care-related industries, including HMO medical centers and nursing care facilities, bolster the growth of life sciences clusters. We studied twenty-four health-care-related industries and ten supporting industries for this purpose. (See the Methodology section at the end of this chapter.)

Components of the Index

The Current Impact Composite Index measures the relative economic outcome of the life sciences industry. The analysis looks at the effects of a positive or negative change in economic activity, assessing the absolute and relative importance of employment size and growth provided by life sciences.

We analyzed each industry using seven measurements, which together comprise the results of the Current Impact Index:

- employment level in 2007
- location quotient (LQ) in terms of employment in 2007
- relative employment growth from 2002 to 2007
- number of establishments in 2007
- number of life sciences industries with location quotients greater than 2.0
- number of life sciences industries with location quotients less than 0.5
- number of life sciences industries growing faster than their United States counterparts from 2002 to 2007

The following table illustrates our metrics of analysis for current impact measurements, along with their definitions:

Components	Definition
Size and Performance	
Employment level	The employment level of each NAICS code will be measured to ascertain the actual number of workers in these industries.
Location quotient (LQ)	Location quotients measure the share of employment of a specific industry with respect to the national share. A location quotient of more than 1.0 indicates that the region has a higher relative concentration of that industry's employment than the national average (taken as 1.0).
Relative growth	This measure looks at the current level of employment indexed to its base year, and then taken as a proportion of the indexed growth in this particular field throughout the United States. A relative growth of 150 percent indicates that the region has grown 50 percent faster than the national average.
Life sciences establishments per 10,000 total establishments	This component shows the share of total establishments engaged in life sciences.
Diversity	
Number of life sciences industries with LQs greater than 2.0	This ascertains the number of life sciences industries in a region that have at least twice the employment concentration locally as they do throughout the United States.
Number of life sciences industries with LQs less than 0.5	This ascertains the number of life sciences industries in a region that are 50 percent or below the employment concentration found throughout the United States.
Number of fast-growing life sciences industries	This refers to the number of life sciences industries in a region that grew faster locally than across the United States as a whole within the five-year period.

The first four components focus on issues of size and performance, while the latter three measure diversity. The Current Impact Composite Index, comprising these seven components, provides a relative snapshot of the current economic impact or outcome.

Size and Performance

The competitiveness of each metro's life sciences industry in terms of economic outcome, size, and performance is measured by employment level, employment concentration as measured by location quotient, relative employment growth indexed to the U.S. average for this industry, and the number of life sciences establishments per 10,000 establishments.

The employment level is defined by employment size in 2007. The location quotient is an index for comparing a metro's share of employment in a particular industry relative to the national share. A metro with a location quotient greater than 1.0 means that it has a higher concentration of life sciences employment relative to the United States as a whole. A location quotient equal to 1.0 indicates that the metro has an industry employment share on par with the share across the entire nation. A metro with a location quotient of less than 1.0 means that the area has a smaller share of industry employment than is found nationally.

Relative employment growth for each metro was measured by the current level of employment in life sciences indexed to its base year (2002) and then taken as a proportion of the indexed growth of the life sciences nationally. If a metro's relative indexed growth is 120, it indicates that its life sciences industry grew 20 percent above the national average. Relative indexed growth of 80 implies that the metro grew 20 percent below the national average.

The number of life sciences establishments per 10,000 total establishments in each metro also affects the current impact assessment. For example, a particular metro with 100,000 total business establishments but only ten engaged in life sciences means that there is only one life sciences establishment for every 10,000 total establishments in the metro.

Diversity

The following three indicators of diversity in the life sciences were measured for each metro. The diversity present in a given metro was then compared to results in the other metros studied. These indicators were:

- the number of life sciences industries with employment location quotients (LQs) greater than 2.0
- the number of life sciences industries with employment LQs less than 0.5
- the number of life sciences industries in which employment grew faster than the national average

The first diversity measure focused on metropolitan areas that have at least twice the employment concentration of the national average in the life sciences industry. The second diversity measure listed above identifies metropolitan areas that are 50 percent or below the national average.

Based on this methodology, our diversity measures allowed us to rule out extremes. For instance, a metro with a very high employment location quotient due to a low overall employment base could result in distorted conclusions. The diversity measurements equalize the results by attributing the same amount of significance to any LQ above 2.0, whether it is 2.5 or 15; this is likewise for metros whose LQ is less than 0.5.

The third diversity measure is the number of life sciences industries in a given metropolitan area whose employment grew faster than the U.S. average between 2002 and 2007. This measure identified the metros that experienced strong relative growth in recent years versus those that did not. A metro with a life sciences employment base and a high employment location quotient may still have grown at a slower pace relative to other parts of the nation. A possible explanation for this phenomenon might be that the metropolitan area is losing some of its employment to other parts of the country and/or not effectively capitalizing on its resources or inputs. Alternatively, the cluster may have reached a level of maturity that restricts its growth relative to smaller, younger clusters.

Since much of each metro's success in life sciences is owed to its supporting industries and to health-care service industries, the analysis also applied the following two diversity measures to the twenty-four health-care-related and ten life science–supporting industries:

- number of life science–supporting industries with employment LQs greater than 1.0
- number of life science–supporting industries with employment LQs less than 0.75
- number of health-care service industries with employment LQs greater than 1.0
- number of health-care service industries with employment LQs less than 0.75

Current Impact Composite Index: Results

The Current Impact Composite Index totals the seven components used in determining the current impact measures.

The composite index was calculated using the following methodology (for further details, see the section at the end of this chapter). For each industry, each metro was benchmarked to the top-performing location in that category, creating a normalized scoring system that could be consistently compared across each measure. Doing this eliminates extreme bias. In the second step, unique weights were assigned to each of the seven components in order to arrive at a composite solely for therapeutics and devices. The weights are indicative of each measure's relative importance and contribution to the metro's overall performance. Since size and performance constitute a primary indicator when measuring economic outcome, we acknowledged this fact by assigning them greater weight in this analysis. Thus, if a metro ranked 1st in every industry that is part of therapeutics and devices, it would earn a score of 100 and rank 1st in the overall composite for therapeutics and devices. The process was then repeated for the fields that comprise health-care services and life science-supporting industries.

The last step in arriving at the total Current Impact Composite Index was to combine the sum of the weighted composite index of the therapeutics and devices industry with the results for health-care-related industries and life science–supporting industries.

Greater Philadelphia claims the top spot in our Current Impact Composite Index, followed closely by Greater New York and Boston. (Boston has moved from 4th place in our 2005 study to take 3rd place.) While the previous study saw Greater Philadelphia beating out Greater New York by only 0.3 index point, that lead has increased to 7.0 index points. This strengthened position can be largely attributed to the metro's improved performances in biotechnology R&D (which boosted its position to 1st in therapeutics and devices from 3rd in our 2005 study), health-care services, and life science–supporting industries.

Current Impact Composite Index
2007

Rank	Metro area	Therapeutics and devices	Supporting industries	Health-care industries	Composite score
1	Greater Philadelphia	100	100	81	100
2	Greater New York	88	76	100	93
3	Boston	99	67	61	91
4	Greater San Francisco	86	74	49	81
5	Greater Raleigh-Durham	88	63	44	80
6	Greater Los Angeles	82	67	61	79
7	Chicago	79	67	58	76
8	Minneapolis	77	71	42	72
9	San Diego	74	51	36	67
10	Washington, D.C.	62	39	68	63
11	Seattle	55	31	50	54

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

In the pages that follow, we will discuss the results in individual industry categories that informed the overall rankings given in the table above.

Therapeutics and Devices

The therapeutics and devices category is remarkably vibrant in Greater Philadelphia, which ranked 2nd in employment size, relative growth, and employment concentration. In 2007, 56,300 workers were employed in therapeutics and devices in the metro area. Only New York exceeded this total, with about 68,062 jobs in 2007 (see the table in the Appendix). Montgomery County registered 24,745 therapeutics and devices employees, representing 5.5 percent of the county's total employment in 2007. Merck & Company and GlaxoSmithKline are two prominent local employers, accounting for a major share of these jobs in the county.

Greater Philadelphia's employment in therapeutics and devices (T&D)
Ranked by employment location quotient, 2007

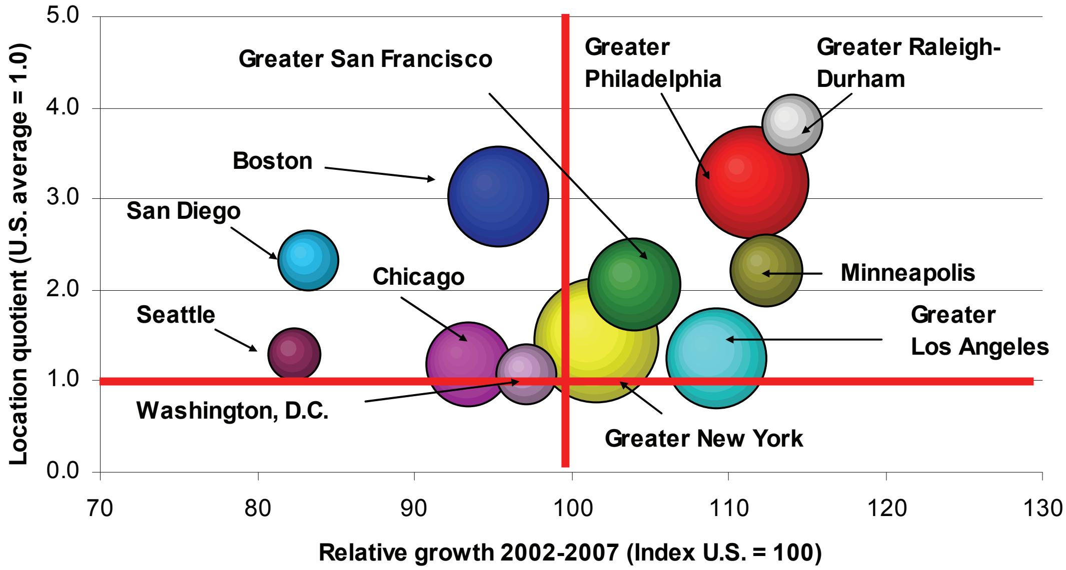
Rank	County	County employment	Workers in T&D	Percent of employment	Location quotient
1	Montgomery County, Pennsylvania	452,098	24,745	5.5	7.7
2	Mercer County, New Jersey	159,773	6,958	4.4	6.2
3	New Castle County, Delaware	250,264	9,122	3.6	5.2
4	Chester County, Pennsylvania	218,498	7,692	3.5	5.0
5	Salem County, New Jersey	18,366	175	1.0	1.3
6	Bucks County, Pennsylvania	240,817	2,172	0.9	1.3
7	Camden County, New Jersey	174,650	1,097	0.6	0.9
8	Philadelphia County, Pennsylvania	528,154	2,845	0.5	0.8
9	Gloucester County, New Jersey	86,199	459	0.5	0.8
10	Delaware County, Pennsylvania	185,983	785	0.4	0.6
11	Burlington County, New Jersey	172,513	241	0.1	0.2
12	Cecil County, Maryland	23,394	10	0.0	0.1
	Total	**2,510,709**	**56,300**	**2.2**	**3.2**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

The strengths and weaknesses of each metro in therapeutics and devices employment concentration, growth, and size are depicted in the three-dimensional bubble chart below. (The most desirable outcome would be a large bubble in the upper-right quadrant of the graph.) The vertical y-axis illustrates therapeutics and devices employment concentration in each location, while the horizontal x-axis relates to each metro's relative life sciences industry growth from 2002 to 2007. The size of each bubble is indicative of each metro's employment size in therapeutics and devices.

Life sciences therapeutics and devices industry

Employment: concentration, growth, and size



Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris Info Source, Milken Institute.

Six metros out of the eleven analyzed show relative employment growth to the right of the vertical line, which is set at 100 (representing the U.S. average). Out of these six metros, Greater Philadelphia, Greater Raleigh-Durham, and Minneapolis are also substantially above the heavy horizontal line at 1.0, indicating strong employment concentration relative to the national average. Greater Philadelphia's concentration of therapeutics and devices employment was a little over three times the national average, registering an LQ of 3.17 in 2007. Greater Raleigh-Durham ranked 1st for therapeutics and devices employment concentration, with an LQ of 3.8. The region also emerged as the top performer for indexed relative employment growth between 2002 and 2007 (coming in at 114, compared to the U.S. average of 100). Greater Philadelphia ranked 2nd in this measure, tying with Minneapolis for relative employment growth between 2002 and 2007 (scoring 112 each).

Minneapolis, with an LQ of 2.2, relative employment growth of 112, and employment size of 24,071, is also positioned to build on its strengths in therapeutics and devices. Out of the eleven metros studied, Greater Los Angeles ranked 3rd in terms of absolute employment (46,534) and 4th in terms of relative employment growth (109). It is particularly interesting to see that Greater New York ranked 1st in terms of absolute employment, but 7th in terms of concentration (with an LQ of 1.4) and 6th in relative growth (102). Greater San Francisco, by contrast, ranked 5th in absolute employment (37,466) but relatively better when looking at its LQ and relative growth.

The following table shows the scores for each component in the composite index for therapeutics and devices. (The top-ranking metro in each category is assigned a score of 100, and other metros are benchmarked accordingly.) After finishing 3rd in this particular index in our 2005 analysis (behind Greater San Francisco and San Diego, which both fell in the current analysis), Greater Philadelphia leapt to claim top honors in this year's ranking. The metro area beat out Boston by one point, the slimmest of margins. The primary reasons for Greater Philadelphia's improved performance were gains in biotechnology (where its index score rose from 33 in our 2005 study to 61 this year) and a solid move from 4th to 2nd in life sciences R&D (principally within biotech). Greater Raleigh-Durham and Greater New York shared the 3rd position. The pages that follow will detail the results in the various specialties that make up the therapeutics and devices category.

Composite index scores for therapeutics and devices

		Size and performance scores				Diversity scores			
Rank	Metro area	Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Philadelphia	83	83	98	50	73	83	82	100
2	Boston	66	80	84	84	100	71	64	99
3	Greater Raleigh-Durham	25	100	100	69	82	63	73	88
3	Greater New York	100	38	89	32	64	83	82	88
5	Greater San Francisco	55	54	91	45	82	100	100	86
6	Greater Los Angeles	68	33	96	28	73	100	100	82
7	Chicago	47	31	82	100	64	63	91	79
8	Minneapolis	35	58	99	61	64	56	91	77
9	San Diego	27	61	73	57	73	100	64	74
10	Washington, D.C.	25	28	85	47	82	45	91	62
11	Seattle	20	34	72	43	55	50	82	55

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

The following table lists the three diversity measures by metropolitan area for therapeutics and devices. As previously noted, the first diversity measure looked at the number of industries with a location quotient greater than 2.0, and as the table shows, Greater Philadelphia has four industries in the therapeutics and devices category with LQs above this line. Two other industries in the metro have LQs of less than 0.5. Another positive impact of Greater Philadelphia's reputation as a cluster for life sciences is that five of the industries in the therapeutics and devices category grew faster than the U.S. average from 2002 to 2007.

Diversity measures in therapeutics and devices

2007

Metro area	Number of industries LQ >2	Number of industries LQ <0.5	Number of industries growing faster than U.S. 2002-2007
Boston	7	3	3
Chicago	3	4	6
Washington, D.C.	5	7	6
Greater Los Angeles	4	1	7
Greater New York	3	2	5
Greater Philadelphia	4	2	5
Greater Raleigh-Durham	5	4	4
Greater San Francisco	5	1	7
Minneapolis	3	5	6
San Diego	4	1	3
Seattle	2	6	5

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

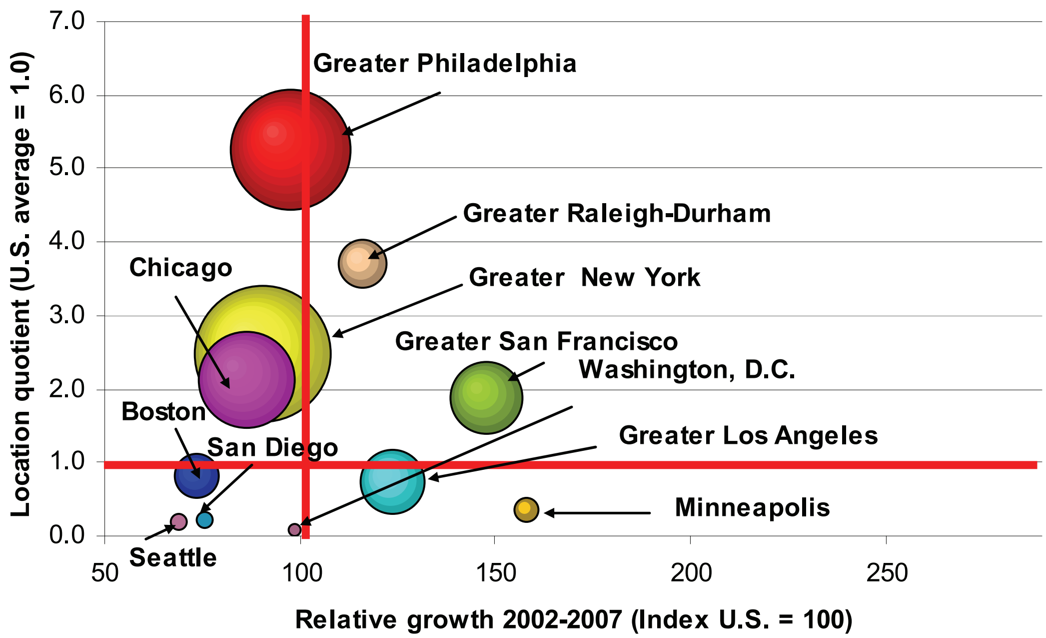
The following section analyzes the therapeutics and devices category by industry segment in each of the eleven metros. Therapeutics and devices encompasses a total of twelve industries at the six-digit NAICS level.

Pharmaceuticals

A key component of the therapeutics and devices category is the pharmaceuticals industry, which is a particularly crucial economic force in Greater Philadelphia. The bubble chart below illustrates the metro's dominance in this field, which is driven by the considerable footprint of leading pharmaceutical firms such as Merck & Company, GlaxoSmithKline, and AstraZeneca. The large labor pool employed by these companies is a major driver of economic growth for the region. Notably, in Greater Philadelphia, 47 percent of therapeutics and devices employment was in pharmaceuticals in 2007. The region ranked first among the eleven metros for employment LQ (5.3), though its indexed relative growth was just slightly below the national average (98).

Pharmaceuticals industry

Employment: concentration, growth, and size



Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris Info Source, Milken Institute.

Greater Philadelphia ranked 1st on the pharmaceuticals composite index, scoring 100 in employment concentration and ranking 2nd on the diversity measures. While this remains a stellar position, the metro cannot afford to be complacent: Greater New York moved 10 index points closer to Greater Philadelphia this year than in our 2005 study.

Composite index scores for the pharmaceuticals industry

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Philadelphia	80	100	62	92	100	100	50	100
2	Greater New York	100	47	57	79	100	100	50	91
3	Greater Raleigh-Durham	14	70	73	83	100	100	100	77
4	Greater San Francisco	29	36	93	58	50	100	100	67
5	Chicago	49	40	55	34	100	100	50	66
6	Greater Los Angeles	23	14	78	41	50	100	100	54
7	Boston	10	15	47	100	50	100	50	53
8	Minneapolis	3	7	100	32	50	50	100	43
9	San Diego	2	4	48	72	50	50	50	37
10	Washington, D.C.	1	1	62	36	50	50	50	33
11	Seattle	2	3	44	26	50	50	50	28

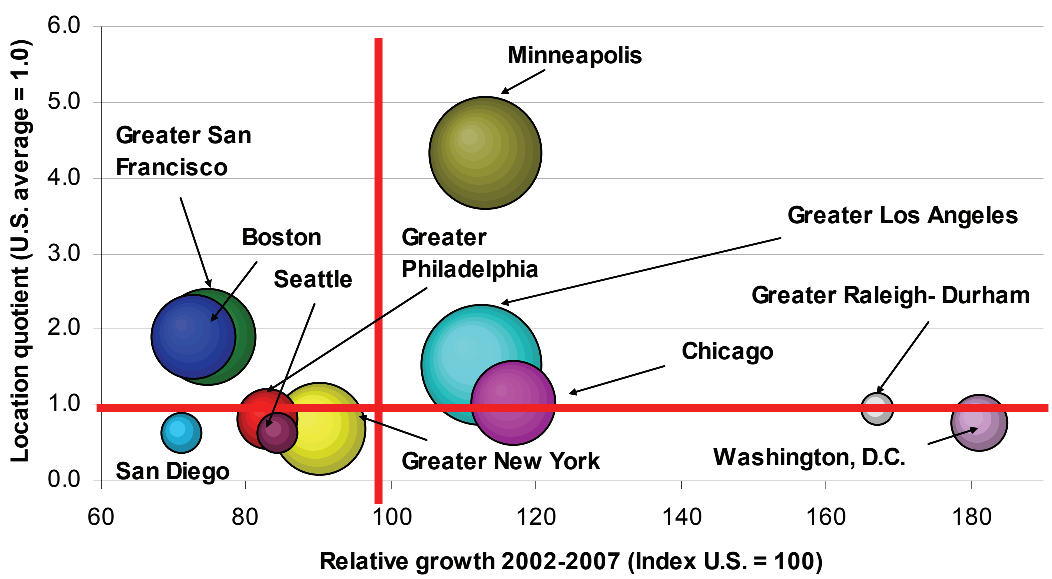
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Medical Devices

Greater Philadelphia compared less favorably to other leading metros in terms of absolute employment size, employment concentration, and relative growth of the medical devices industry. Greater Los Angeles posted the highest number of jobs in medical devices, with 26,568 people employed in this field in 2007, while Minneapolis had the highest employment concentration at 4.3.

Medical devices industry

Employment: concentration, growth, and size



Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris Info Source, Milken Institute.

Minneapolis has long been recognized as a leader in this field, and it once again ranked 1st on the medical devices composite index. Greater Philadelphia, meanwhile, slipped from 8th place in the 2005 study to 10th place in this year's assessment.

Composite index scores for the medical devices industry

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Minneapolis	82	100	62	58	100	50	100	100
2	Greater Los Angeles	100	35	62	25	100	100	83	88
3	Chicago	50	24	64	100	75	50	100	75
4	Greater San Francisco	61	44	41	32	100	50	50	67
5	Boston	50	44	40	32	100	25	17	58
6	San Diego	23	39	39	33	50	100	67	54
7	Washington, D.C.	22	18	100	19	75	17	100	52
8	Greater New York	57	16	50	25	25	33	50	47
9	Greater Raleigh-Durham	7	22	92	26	25	20	50	39
10	Greater Philadelphia	25	19	46	27	25	33	67	38
11	Seattle	11	15	46	33	25	20	100	35

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

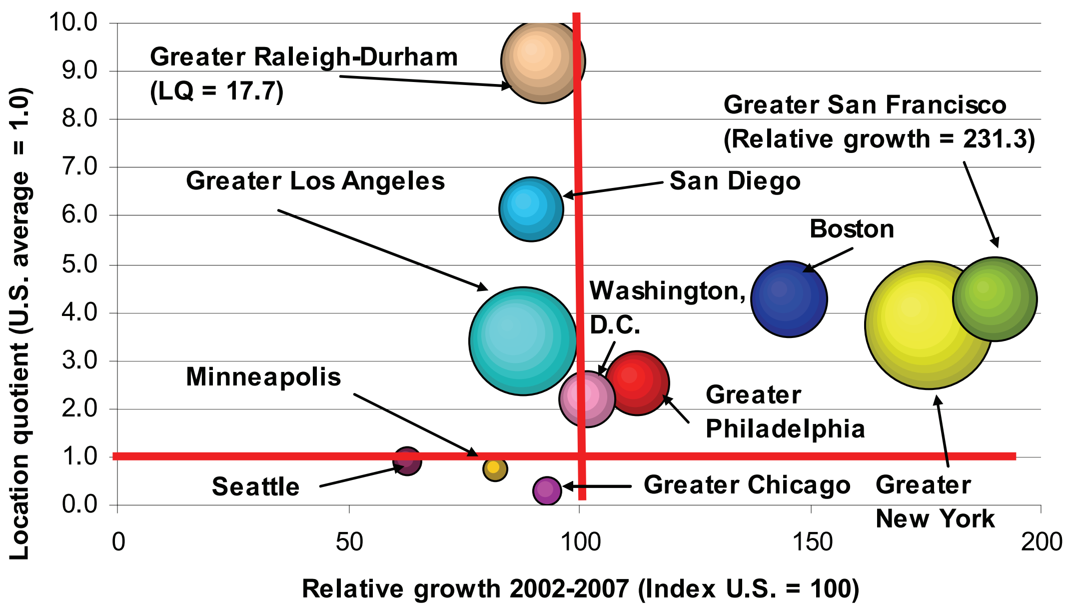
Biotechnology

There were 3,702 workers employed in biotechnology in Greater Philadelphia in 2007, accounting for 6.5 percent of the metro's therapeutics and devices employment. Among the largest local firms primarily engaged in this field is Janssen Pharmaceuticals, a subsidiary of Johnson & Johnson.

The employment LQ of Greater Philadelphia in biotechnology is 2.5, placing it 7th. Greater Raleigh-Durham's employment concentration was the highest among all eleven metros, registering 17.7 in 2007.

Biotechnology industry

Employment: concentration, growth, and size



Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris Info Source, Milken Institute.

Greater Raleigh-Durham topped the chart in composite index for biotechnology, while Greater Philadelphia posted a relatively low result, with an index score of 61. (This is partially explained by the fact that most biotechnology employment in Philadelphia stems from R&D in this field, and those activities are captured in a different measure, discussed below.) Nevertheless, this outcome was an improvement on Greater Philadelphia's position in 2005.

Composite index scores for the biotechnology industry

		Size and performance scores				Diversity scores			
Rank	Metro area	Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Raleigh-Durham	45	100	40	55	100	100	25	100
2	Greater New York	100	21	76	22	75	100	75	98
3	Greater San Francisco	44	24	100	38	75	100	100	89
4	Boston	36	24	63	45	100	100	75	80
4	San Diego	27	35	39	100	75	100	25	80
6	Greater Los Angeles	72	19	38	21	50	100	50	72
7	Greater Philadelphia	25	14	49	30	75	100	50	61
8	Washington, D.C.	20	12	44	29	75	50	50	50
9	Chicago	5	2	40	42	25	33	50	33
9	Seattle	5	5	27	28	50	50	25	33
11	Minneapolis	5	4	35	30	25	33	25	28

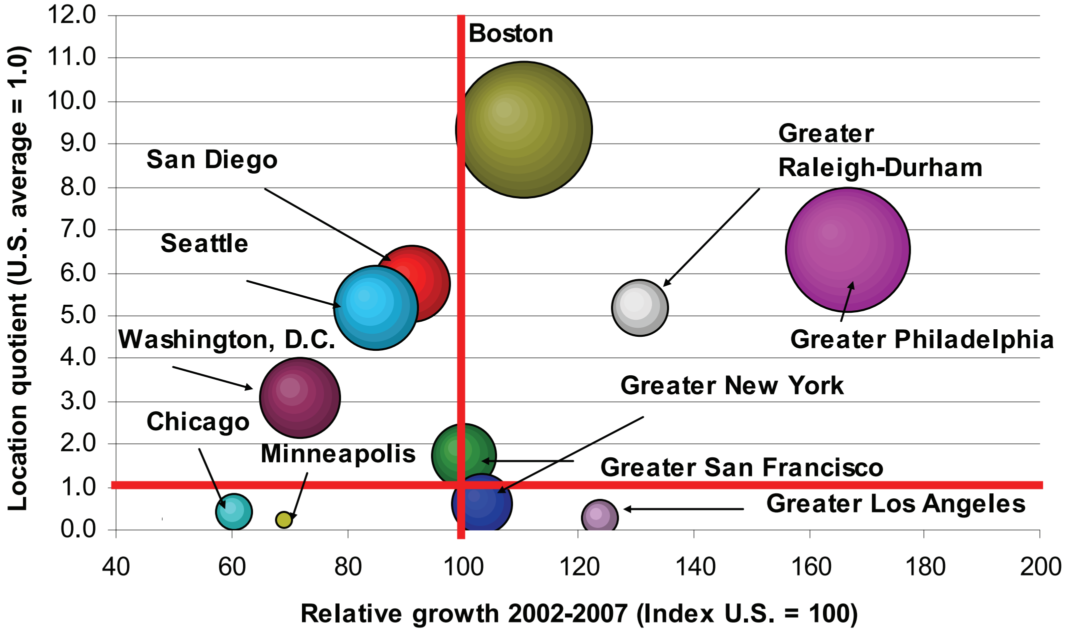
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Research and Development

R&D in the life sciences is the category capturing R&D in biotechnology. In fact, most of this category is now biotechnology. Because of changes to the 2007 NAICS structure, we can only estimate R&D in biotechnology in years prior to 2007. Some of the R&D previously contained in this category has been shifted into pharmaceutical and medical device manufacturing categories, although many of these activities still remain in this R&D code.

Focusing on R&D in the life sciences reveals that Greater Philadelphia does relatively better than most of the other metros in terms of absolute employment; 34.6 percent of the metro's therapeutics and devices jobs were in R&D. Its employment in this category between 2002 and 2007 also grew relatively faster than the U.S. average, placing the metro 1st (167) in employment growth. The strength of Greater Philadelphia's biotech R&D employment is a major factor propelling the metro to the 1st-place ranking in the overall composite for therapeutics and devices (up from 3rd in our 2005 analysis). Improved access to seed and early-stage risk capital appears to have played a role in promoting growth in this sector.

R&D in the life sciences industry
Employment: concentration, growth, and size



Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris Info Source, Milken Institute.

Greater Philadelphia scored 100 on four of the seven R&D measures, a strong performance that won the metro a 2nd-place ranking in the overall composite index for R&D. Boston topped the chart with a perfect score of 100 in six out of seven measures.

Composite index scores for R&D in life sciences

		Size and performance scores				Diversity scores			
Rank	Metro area	Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Boston	100	100	66	100	100	100	100	100
2	Greater Philadelphia	84	70	100	39	100	100	100	85
3	Greater Raleigh-Durham	17	55	78	80	100	100	100	67
4	San Diego	32	61	55	38	100	100	50	60
5	Seattle	38	55	51	23	100	100	50	57
6	Washington, D.C.	35	33	43	56	100	100	50	56
7	Greater San Francisco	22	18	60	24	50	100	100	44
8	Greater New York	21	7	62	9	50	100	100	39
9	Greater Los Angeles	7	3	74	5	50	50	100	31
10	Chicago	8	5	36	18	50	50	50	25
11	Minneapolis	2	2	42	14	50	50	50	23

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Health-Care Services and Life Science–Supporting Industries

While our 2005 study combined these two categories, we have separated health-care services from life science–supporting industries in our current analysis to reflect its integral role in any knowledge-intensive life sciences cluster.

The following table presents an overview of the relative size of the twenty-four health-care-related industries in each metro, examining absolute employment and employment concentration. In 2007, Greater Philadelphia employed 283,026 people in health-care services, which accounted for 11.3 percent of the region's total employment. The aggregate employment LQ of 1.1 indicates a slightly higher concentration of health-care-related industries in Greater Philadelphia than the national average.

Employment in health-care services

Ranked by location quotient, 2007

Rank	Metro area	Workers in health-care industries	Total area workers	Percent of metro area	Location quotient
1	Greater New York	893,252	6,677,475	13.4	1.3
2	Washington, D.C.	275,918	2,256,915	12.2	1.2
3	Boston	244,603	2,099,975	11.6	1.2
4	Greater Philadelphia	283,026	2,510,709	11.3	1.1
5	Chicago	371,241	3,829,913	9.7	1.0
6	Seattle	124,392	1,457,203	8.5	0.9
7	Greater Raleigh-Durham	54,075	633,598	8.5	0.9
8	Greater San Francisco	216,998	2,564,208	8.5	0.8
9	Greater Los Angeles	438,843	5,254,369	8.4	0.8
10	Minneapolis	126,634	1,531,508	8.3	0.8
11	San Diego	76,668	1,101,128	7.0	0.7
	United States	11,364,841	114,012,221	10.0	1.0

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Greater Philadelphia ranked 2nd on the health-care services composite index, placing below Greater New York.

Composite index scores for health-care services

Rank	Metro area	Size and performance scores: Employment 2007	Size and performance scores: Location quotient 2007	Diversity scores: Number of industries LQ >1	Diversity scores: Number of industries LQ <0.75	Composite index score
1	Greater New York	100	100	89	100	100
2	Greater Philadelphia	32	84	100	100	81
3	Washington, D.C.	31	91	74	33	68
4	Greater Los Angeles	49	62	79	40	61
5	Boston	27	87	53	29	61
6	Chicago	42	72	47	40	58
7	Seattle	14	64	68	25	50
8	Greater San Francisco	24	63	58	22	49
9	Greater Raleigh-Durham	6	64	47	22	44
10	Minneapolis	14	62	42	15	42
11	San Diego	9	52	37	18	36

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

In Greater Philadelphia, only two out of the twenty-four health-care-related industries had LQs of less than 0.75. Nineteen had employment concentrations above the national average in 2007.

Diversity measures in health-care services

2007

Metro area	Number of industries LQ >1	Number of industries LQ <0.75
Boston	10	7
Chicago	9	5
Washington, D.C.	14	6
Greater Los Angeles	15	5
Greater New York	17	2
Greater Philadelphia	19	2
Greater Raleigh-Durham	9	9
Greater San Francisco	11	9
Minneapolis	8	13
San Diego	7	11
Seattle	13	8

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

The following table presents an overview of the relative size of the industries that support the life sciences, examining absolute employment and employment concentration across the eleven metros.

Employment in life science–supporting industries

Ranked by location quotient, 2007

Rank	Metro area	Workers in life sciences-supporting industries	Total area workers	Percent of metro area	Location quotient
1	Minneapolis	39,186	1,531,508	2.6	1.6
2	Greater Philadelphia	60,187	2,510,709	2.4	1.5
3	Greater Raleigh-Durham	13,755	633,598	2.2	1.4
4	Boston	42,331	2,099,975	2.0	1.3
5	Greater New York	123,403	6,677,475	1.8	1.2
6	Chicago	63,741	3,829,913	1.7	1.0
7	Greater San Francisco	42,492	2,564,208	1.7	1.0
8	San Diego	18,236	1,101,128	1.7	1.0
9	Greater Los Angeles	85,452	5,254,369	1.6	1.0
10	Washington, D.C.	28,880	2,256,915	1.3	0.8
11	Seattle	14,705	1,457,203	1.0	0.6
	United States	1,807,854	114,012,221	1.6	1.0

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

In 2007, 60,187 workers in Greater Philadelphia were employed in life science–supporting industries, accounting for 2.4 percent of the region's total employment. The aggregate employment LQ of 1.5 indicates that the concentration of these industries in Greater Philadelphia is 50 percent higher than the national average.

Greater Philadelphia ranked 1st on the life science–supporting industries composite index, followed by Greater New York and San Francisco.

Composite index scores for life science–supporting industries

Rank	Metro area	Size and performance scores: Employment 2007	Size and performance scores: Location quotient 2007	Diversity scores: Number of industries LQ >1	Diversity scores: Number of industries LQ <0.75	Composite index score
1	Greater Philadelphia	49	94	100	100	100
2	Greater New York	100	72	44	33	76
3	Greater San Francisco	34	65	67	100	74
4	Minneapolis	32	100	33	25	71
5	Greater Los Angeles	69	64	56	33	67
6	Boston	34	79	56	33	67
7	Chicago	52	65	56	50	67
8	Greater Raleigh-Durham	11	85	56	20	63
9	San Diego	15	65	44	25	51
10	Washington, D.C.	23	50	22	13	39
11	Seattle	12	39	22	14	31

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

In Greater Philadelphia, only one out of the ten supporting industries had an LQ of less than 0.75, while nine had employment concentrations above the national average in 2007.

Diversity measures in life science–supporting industries

2007

Metro area	Number of industries LQ >1	Number of industries LQ <0.75
Boston	5	3
Chicago	5	2
Washington, D.C.	2	8
Greater Los Angeles	5	3
Greater New York	4	3
Greater Philadelphia	9	1
Greater Raleigh-Durham	5	5
Greater San Francisco	6	1
Minneapolis	3	4
San Diego	4	4
Seattle	2	7

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

The Broader Role of Health-Care Services and Industries That Support the Life Sciences in Greater Philadelphia

We have already analyzed employment numbers in health-care services and other industries that support the life sciences. But jobs are only one part of the story; the impact of these fields is actually more extensive and profound. These industries are a foundational building block for the life sciences; in many cases, they represent the ultimate delivery mechanism for the innovation and activity generated throughout the sector. In Greater Philadelphia these industries are effectively tied back into the greater life sciences economy, complementing the strong presence of the pharmaceutical industry in and around the city.

Philadelphia boasts significant and high-profile assets in this arena—namely, its prestigious general and specialty medical schools and research hospitals. Not only do the region's medical research centers create relatively high-wage jobs, but they also attract grants and investment from both the public and private sectors. The prominence of these medical facilities also helps to account for the unusually low concentrations of HMO medical centers (LQ=0.8) and freestanding medical centers (LQ=0.3) compared to the national average. University-affiliated hospitals such as those associated with the University of Pennsylvania, Temple University, and Drexel University keep Philadelphia at the forefront of advanced medical techniques.

The University of Pennsylvania School of Medicine is a particularly noteworthy asset. The nation's first medical school, it remains top-ranked to this day. Its network of affiliated hospitals, exceptional teaching programs, and highly regarded dental and nursing schools serves as the principal focal point for medical training and research in the Greater Philadelphia area. The Hospital of the University of Pennsylvania School of Medicine is regularly ranked among the nation's best by *U.S. News & World Report* (in fact, in 2008, it was one of only nineteen hospitals across the entire nation to make the publication's "Honor Roll").[1]

Thomas Jefferson University is another prominent dedicated medical university in Greater Philadelphia; it is also one of the metro area's largest local employers in both the university and its managed hospitals. The graduate school provides programs in numerous physical science disciplines such as biology, genetics, and pharmacology, supplementing a strong medical program.[2] The university's highly regarded hospitals (including the Jefferson Hospital for Neuroscience) are nationally recognized. *U.S. News & World Report* has ranked Thomas Jefferson Hospitals among the nation's best for orthopedic surgery and rehabilitation.[3]

Temple University, like the University of Pennsylvania, plays a significant role, not only in medical research and the training of medical professionals but also in health-care delivery and the overall life science–supporting industries. In 2008, fifty-one Temple physicians were named in a survey of their peers as "Best Doctors in America 2007–2008."[4] The Temple University Health System, like UPenn's, encompasses a network of multiple hospitals.

The following table shows that Greater Philadelphia has a strong constellation of hospitals. The industry category of general medical and surgical hospitals accounted for 4.2 percent of Greater Philadelphia's total employment in 2007. Also noteworthy, Greater Philadelphia has 50,130 employees in the offices of physicians category (which excludes mental health providers), representing 2 percent of the metro's employment.

1. "America's Best Hospitals 2008," *U.S. News & World Report*, July 21, 2008 ("Honor Roll" list can be accessed at http://health.usnews.com/articles/health/best-hospitals/2008/07/10/best-hospitals-honor-roll.html).
2. http://www.jefferson.edu/jcgs/programs.cfm
3. http://www.jeffersonhospital.org/news/2007/article16465.html
4. http://www.temple.edu/medicine/best_docs_2008.htm

Employment in health-care services
Greater Philadelphia, 2007

Industry	NAICS codes	Workers in the industry	Percent of total area employment	Location quotient
Offices of physicians (except mental health specialists)	621111	50,130	2.0	1.1
Offices of physicians, mental health specialists	621112	1,716	0.1	1.8
Offices of dentists	621210	17,998	0.7	1.0
Offices of chiropractors	621310	2,671	0.1	1.0
Offices of optometrists	621320	1,960	0.1	0.9
Offices of mental health practitioners (except physicians)	621330	7,491	0.3	6.1
Offices of physical, occupational and speech therapists, and audiologists	621340	5,638	0.2	1.1
Offices of podiatrists	621391	1,325	0.1	1.7
Offices of all other miscellaneous health practitioners	621399	1,986	0.1	1.7
Family planning centers	621410	561	0.0	1.2
HMO medical centers	621491	1,364	0.1	0.8
Kidney dialysis centers	621492	2,439	0.1	1.4
Freestanding ambulatory surgical and emergency centers	621493	570	0.0	0.3
All other outpatient care centers	621498	3,767	0.2	1.9
Medical laboratories	621511	4,239	0.2	1.3
Diagnostic imaging centers	621512	1,711	0.1	1.2
Home health-care services	621610	17,844	0.7	0.9
Ambulance services	621910	4,044	0.2	1.4
Blood and organ banks	621991	140	0.0	0.1
All other miscellaneous ambulatory health-care services	621999	2,128	0.1	3.2
General medical and surgical hospitals	622110	106,562	4.2	1.2
Psychiatric and substance abuse hospitals	622210	4,622	0.2	2.2
Specialty (except psychiatric and substance abuse) hospitals	622310	6,031	0.2	1.6
Nursing care facilities	623110	36,089	1.4	1.0
Total		**283,026**	**11.3**	**1.1**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

As we will discuss further in the following section, the clustering effect of the life sciences has played a significant role in the region's overall economic development. One supporting industry that has particularly benefited has been chemical manufacturing. Greater Philadelphia has a strong concentration in basic organic and inorganic chemical manufacturing, as shown in the table on the following page. In fact, the table reveals that the metro posted slightly higher LQs than the national average for virtually all life science–supporting industries except ophthalmic goods merchant wholesalers.

Employment in life science–supporting industries
Greater Philadelphia, 2007

Industry	NAICS codes	Workers in the industry	Percent of total area employment	Location quotient
Ophthalmic goods merchant wholesalers	42346	105	0.0	0.2
Druggists' goods merchant wholesalers	42421	7,774	0.3	1.7
Pharmacies and drugstores	44611	21,581	0.9	1.3
Optical goods stores	44613	1,786	0.1	1.3
All other basic inorganic chemical manufacturing	325188	2,265	0.1	3.2
All other basic organic chemical manufacturing	325199	4,646	0.2	6.2
Optical instrument and lens manufacturing	333314	675	0.0	1.3
Medical equipment and merchant wholesalers	423450	4,897	0.2	1.2
Direct health and medical insurance carriers	524114	11,136	0.4	1.4
Testing laboratories	541380	5,322	0.2	1.6
Total		**60,187**	**2.4**	**1.5**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

In the organic and inorganic chemical manufacturing industry, Greater Philadelphia has benefited from the presence of DuPont (headquartered in Wilmington, Delaware, which is part of the metro area) and the concentration of other chemical manufacturing companies in the region.

The Clustering Effect in Greater Philadelphia

The bulk of this chapter has examined the size and concentration of various life sciences industries in Greater Philadelphia, contrasting against those measurements in other metros. It is clear that Philadelphia has developed a critical mass of assets in this sector. But what is the payoff? What are the larger implications of this industry cluster and the advantages it can bestow on the larger regional economy? Here we will discuss the spatial distribution of life sciences establishments and employment in Greater Philadelphia and the economic benefits stemming from the metro's life sciences cluster.

To remain competitive in the global economy, a region must support and foster growth of the interrelated industries in which that particular region specializes. This agglomeration of interrelated industries is often referred to as a cluster. As one study put it, "A **cluster** is a geographic concentration of competing, complementary or interdependent firms with a common need for talent, technology, infrastructure, etc. Cluster relationships are dynamic and evolve in reaction to market and other forces."[5] A cluster is a complex network of suppliers of specialized inputs and services, complementary products, support institutions, and producers. It may include governmental and nongovernmental entities such as universities, patent attorneys, and venture capitalists—actors that drive innovation in a particular region, thus creating new products, new companies, and higher-skilled/higher-wage jobs.[6] These networks of interrelated industries foster wealth creation in a region, principally through the export of goods and services beyond that region.[7]

5. Southern Minnesota Initiative Foundation. 2004. Cluster Study. Southern Minnesota Industry Inventory and Cluster Analysis Project. http://www.smifoundation.org/clustergeneralexecsumm04.pdf
6. Michael E. Porter, *On Competition* (Boston: Harvard Business School Press, 1998), pp. 218-221.
7. Joel Kotkin and Ross C. DeVol, *Knowledge-Values Cities in the Digital Age* (Milken Institute, 2001).

Each region's industry cluster is unique. Clusters may evolve differently based on varying sub-sector industries, the number and sizes of establishments, purchase-sale linkages, and inter-firm cooperation and collaboration. While a single industry may be at the heart of a cluster, it will need partners and collaboration to endure. Locally based support infrastructures and cross-border partners are key assets in promoting long-term economic growth.

Success in the global economy is increasingly driven by technology and knowledge-driven innovation. A region's future economic performance is linked to its ability to translate research into innovations, giving birth to new technology companies. Industry clusters and their associated support infrastructure—especially those based upon technology agglomerations—are a region's best defense against the global cost-minimization game.

Breakthroughs in the life sciences are changing the way we live and work, and those innovations stem from the creation, accumulation, and exploitation of knowledge. The life sciences industry is increasing its understanding of diseases, and subsequent developing effective new drugs and treatments, thereby providing careers in cutting-edge R&D, high-tech manufacturing, and medical services along the way. As economic activity is increasingly based more on intangible assets, regions with rapidly growing life sciences clusters will be more likely to produce innovations—and less likely to see the economic benefits of those innovations escape to other regions.

Networking these local technology and life sciences clusters to the global business community is another key to regional viability. Finding the right balance on this point allows a given region to retain its local vitality while fully participating in the broader global economy—a process that goes hand-in-hand with creating an environment that attracts and retains footloose companies.[8]

Competition in today's economy is highly dynamic. Companies can lower costs through global sourcing, making the old formulas for success less important. Leveraging innovation competencies is increasingly the key to securing a competitive advantage.[9] Clusters linked to the outside world bring best practices and the latest industry developments to their surrounding region. Advanced information and communication technology now permit local clusters to leverage the talents of cross-border entrepreneurs, who may have returned to their native countries to pursue new opportunities. This development can provide access to lower-cost inputs and the latest tacit knowledge, giving a cluster major advantages. Further, cross-border entrepreneurs open entirely new markets of potential customers.[10]

Geographic clustering of innovative activity is critical. The immediate business environment surrounding a cluster is essential for innovation, competitive success, and sustaining the agglomeration processes. Spatial dimensions of economic activity are central to understanding how an economy works. The fact that knowledge is generated and transmitted more efficiently in close proximity is borne out by the observation that economic activity based on new knowledge has a high tendency to cluster in a geographic area. Agglomeration effects typically arise from three primary sources: labor-force pooling, supplier networks, and technology spillovers.

A life sciences cluster can be a powerful force in determining the relative economic growth of its surrounding region. Greater Philadelphia's strong research expertise, combined with its industrial experience, creates fertile ground for new life sciences establishments. The growth of Greater Philadelphia's life sciences cluster is primarily

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8. Rosabeth Moss Kanter, "Thriving Locally in the Global Economy," *World View: Global Strategies for the New Economy,* Jeffrey E. Garten, editor (Boston: Harvard Business School Press, 2000), pp. 201-225.
9. Michael E. Porter, "Clusters and the New Economics of Competition."
10. AnnaLee Saxenian, *The New Argonauts: Regional Advantage in a Global Economy* (Harvard University Press, 2006), pp. 14-15.

the result of its reputation as a major center for the U.S. pharmaceutical industry and its strong local research infrastructure (including top-ranked universities). It is the eclectic mix of university research, technology spin-out companies from that work, and other startups interacting in a network that encourages companies to move to Greater Philadelphia. Underpinning all this is a mature support network for entrepreneurs, including venture capitalists, high-tech absorptive capacity and providers of professional services.

The map of Greater Philadelphia's life sciences firms by ZIP code in 2007 illustrates this clustering effect. Geographic proximity creates an environment of collaboration, giving rise to new ideas and the further ability to attract additional life sciences companies. Many of these firms are located near I-95.

The densest concentration of life sciences establishments in Greater Philadelphia is found in Montgomery County. The life sciences are a major driver of the county's economy with more than 24,745 people employed in 127 establishments in the therapeutics and devices category. Wyeth Pharmaceuticals and Merck & Co. are among the largest employers in Montgomery County and major contributors to the overall success of the sector. Bucks County ranked 2nd, with ninety-one establishments, primarily focused on medical devices and biotech R&D. In New Castle County, 9,122 people are employed in forty-six establishments; AstraZeneca has a large presence here. With seventy-two establishments, Chester County is another key area of Greater Philadelphia's life sciences industry. Home to Cephalon, it has the potential to add additional jobs and startups to the local economy.

Philadelphia County, with seventy-nine establishments, is the hub for firms such as GlaxoSmithKline. Mercer County's seventy-two establishments include companies such as Janssen Pharmaceuticals and Bristol-Myers Squibb.

The map gives an overview of the spatial dimensions of the Greater Philadelphia life sciences cluster, showing the concentration of employment by area within a ten-mile radius. As it shows, Montgomery County and Philadelphia County are the hubs for employment in therapeutics and devices.

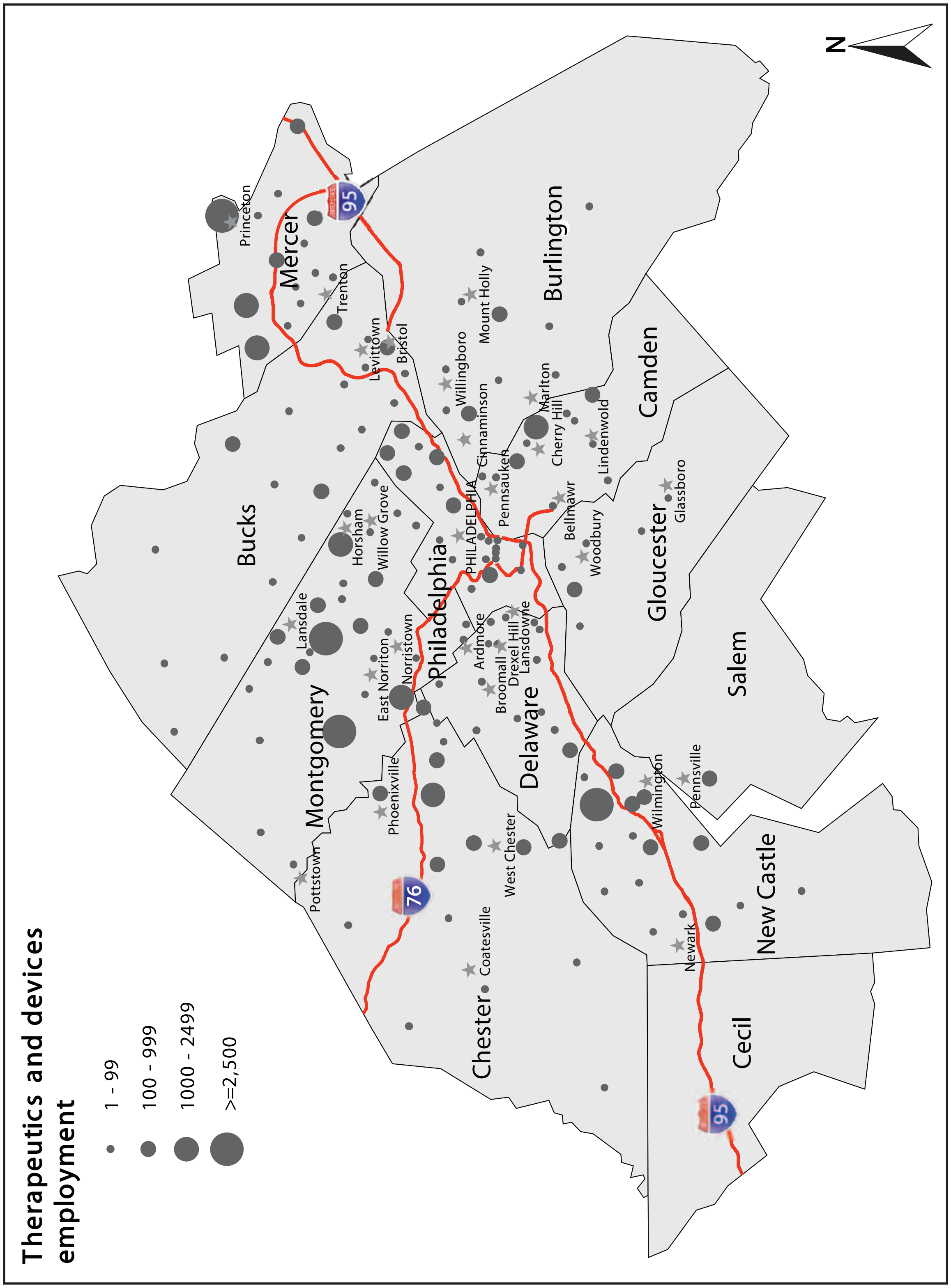
Greater Philadelphia life sciences cluster

Therapeutics and devices industry, ranked by employment, 2007

Rank	County	Number of establishments	Number of workers
1	Montgomery County, Pennsylvania	127	24,745
2	New Castle County, Delaware	46	9,122
3	Chester County, Pennsylvania	72	7,692
4	Mercer County, New Jersey	72	6,958
5	Philadelphia County, Pennsylvania	79	2,845
6	Bucks County, Pennsylvania	91	2,172
7	Camden County, New Jersey	34	1,097
8	Delaware County, Pennsylvania	33	785
9	Gloucester County, New Jersey	11	459
10	Burlington County, New Jersey	25	241
11	Salem County, New Jersey	3	175
12	Cecil County, Maryland	5	10
	Total	**598**	**56,300**

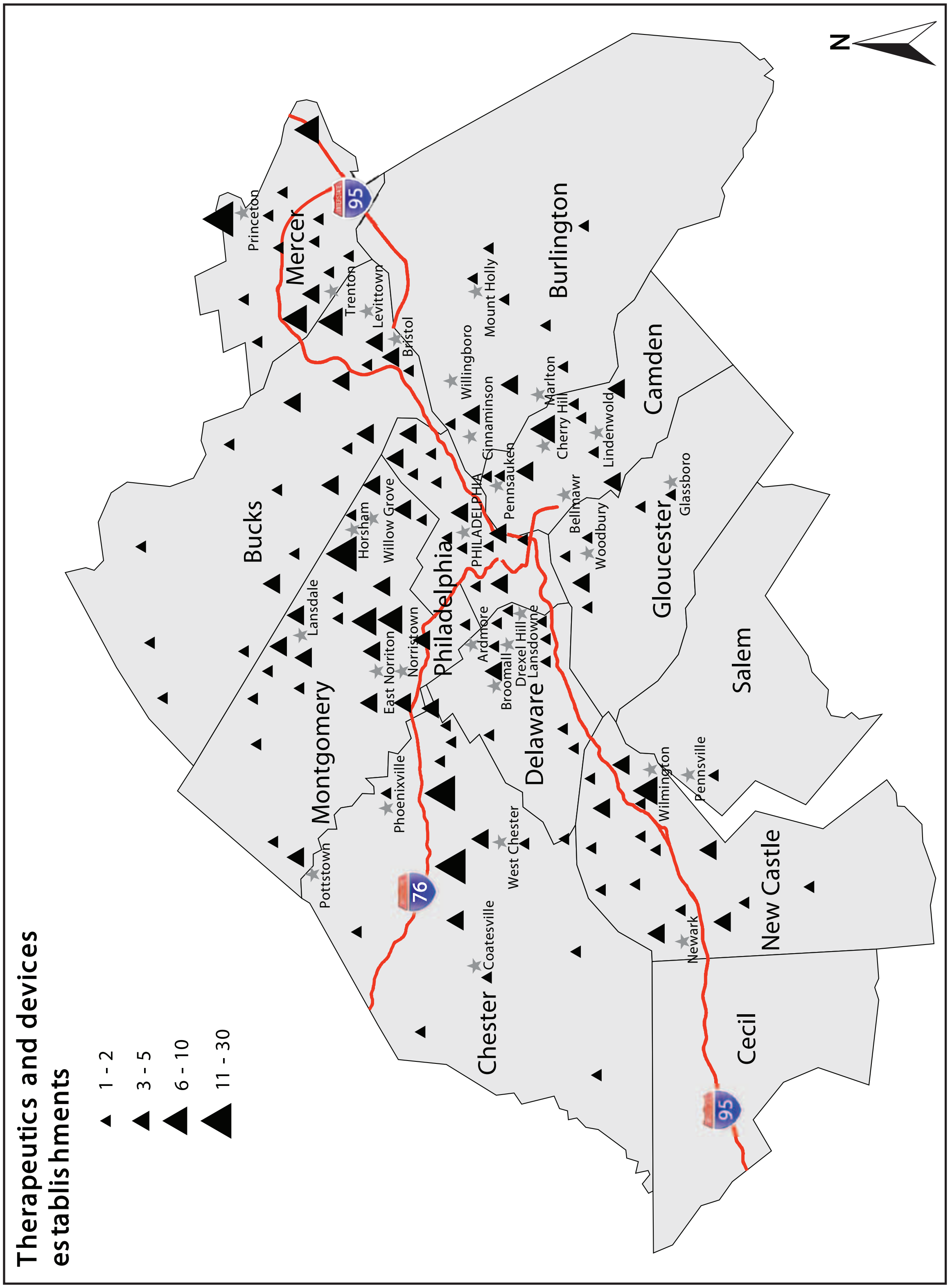
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Greater Philadelphia life sciences cluster
Therapeutics and devices employment centers by ZIP code, 2008



Greater Philadelphia life sciences cluster

Therapeutics and devices establishment locations, 2008



Methodology

This section defines the life sciences industry at a more detailed level and addresses the data sources and estimation techniques used to arrive at the current impact measures.

Defining the Industries

The data for this analysis, based on the 2007 North American Classification System (NAICS) as defined by the federal Office of Management and Budget (OMB), were gathered from a series of government sources.

In measuring the current impact assessment, data were compiled for the therapeutics and devices industries, identified earlier as encompassing biotechnology, medical devices, pharmaceuticals, and life sciences R&D.

The **pharmaceutical industry** includes the following NAICS code:

Defining the pharmaceuticals industry

NAICS code	Definition
325412	Pharmaceutical preparation manufacturing

Source: U.S. Census.

Likewise, the **medical devices** industry is defined using the following 2007 NAICS-based industry classifications.

Defining the medical devices industries

NAICS codes	Definitions
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories
334510	Electromedical apparatus manufacturing
334517	Irradiation apparatus manufacturing

Source: U.S. Census.

There were few changes in the 2007 NAICS-based industry classifications from 2002. In 2007 the classification for surgical appliances and supplies manufacturing (339113) included both 339111 (laboratory apparatus and furniture manufacturing) and 339113 (surgical appliances and supplies manufacturing), which were two separate components in the 2002 classifications.

The table below gives an overview of the 2007 NAICS-based industry classifications that were used in defining the **biotechnology** industry.

Defining the biotechnology industries

NAICS codes	Definitions
325411	Medicinal and botanical manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological product manufacturing

Source: U.S. Census.

Life sciences R&D includes only one NAICS code. In this study we used R& D in biotechnology as our measure for R&D in the life sciences industry. In the 2002 classifications, 541711 was reported as 541710 (Research and Development in the Physical, Engineering, and Life Sciences). Due to changes to the 2007 NAICS structure, we can only estimate R&D in biotechnology prior to 2007.

Defining life sciences R&D

NAICS code	Definition
541711	R&D in biotechnology

Source: U.S. Census.

The **life sciences** industry group encompasses biotechnology, pharmaceuticals, medical devices, and life sciences R&D. The following table displays all of the NAICS in this category.

Defining the therapeutics and devices industries

NAICS codes	Definitions
325411	Medicinal and botanical manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological product manufacturing
541711	R&D in biotechnology
339112	Surgical and medical instrument manufacturing
339113	Surgical applicance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories
334510	Electromedical apparatus manufacturing
334517	Irradiation apparatus manufacturing
325412	Pharmaceutical preparation manufacturing

Source: U.S. Census.

In addition to data on the therapeutics and devices category, this analysis was supplemented by data on health-care services and the industries that support the life sciences.

The industries included in health-care services are summarized in the following table:

Defining the health-care services industries

NAICS codes	Definitions
621111	Offices of physicians (except mental health specialists)
621112	Offices of physicians, mental health specialists
621210	Offices of dentists
621310	Offices of chiropractors
621320	Offices of optometrists
621330	Offices of mental health practitioners (except physicians)
621340	Offices of physical, occupational and speech therapists, and audiologists
621391	Offices of podiatrists
621399	Offices of all other miscellaneous health practitioners
621410	Family planning centers
621491	HMO medical centers
621492	Kidney dialysis centers
621493	Freestanding ambulatory surgical and emergency centers
621498	All other outpatient care centers
621511	Medical laboratories
621512	Diagnostic imaging centers
621610	Home health-care services
621910	Ambulance services
621991	Blood and organ banks
621999	All other miscellaneous ambulatory health-care services
622110	General medical and surgical hospitals
622210	Psychiatric and substance abuse hospitals
622310	Specialty (except psychiatric and substance abuse) hospitals
623110	Nursing care facilities

Source: U.S. Census.

The life science–supporting industries are summarized in the following table.

Defining the life science–supporting industries

NAICS codes	Definitions
333314	Optical instrument and lens manufacturing
325188	All other basic inorganic chemical manufacturing
325199	All other basic organic chemical manufacturing
423450	Medical equipment and merchant wholesalers
42346	Ophthalmic goods merchant wholesalers
42421	Druggists' goods merchant wholesalers
44611	Pharmacies and drugstores
44613	Optical goods stores
524114	Direct health and medical insurance carriers
541380	Testing laboratories

Source: U.S. Census.

Data Estimation Techniques

Data on employment and the number of establishments at the county level for each metropolitan area were obtained from ES202, compiled by the Bureau of Labor Statistics and County Business Patterns from the U.S. Census. Further, final employment numbers for the Greater Philadelphia metro were compared against data from the Harris InfoSource/Selectory.com.

Six of the seven measures for the current impact assessment of therapeutics and devices are based on employment data, while one is based on the number of establishments. The employment data were derived using government-released ES202 and County Business Patterns (CBP) data. The ES202 reports payroll employment derived from the quarterly tax report submitted to state Employment Development Departments (EDDs) that are subject to unemployment insurance (UI) laws. ES202 data were used with four-digit NAICS codes. However, ES202 suffers from a number of missing data, since many firms do not disclose their actual employment values. In such cases, corresponding values (and sometimes mid-point, if a range of employment is provided) from CBP were used. Further, CBP data were used to calculate the shares of employment at a more detailed NAICS level, and then applied to the higher NAICS level from ES202 for those years.

For the R&D in the life sciences industry, we used the value from ES202 NAICS code 541711. R&D data for the Greater Philadelphia metro were further compared with data from Harris InfoSource. Finally, establishment data at the detailed six-digit NAICS level were compiled from ES202. Employment data for health-care services and supporting industries were obtained from the ES202 data. In the case of missing values, CBP data were used. By applying these estimation techniques, we compiled detailed metro employment data up to the six-digit NAICS level for 2002 and 2007.

Metropolitan Statistical Area Changes

The Office of Management and Budget (OMB) defines metropolitan statistical areas. Using 2000 census data, the OMB has revised metropolitan statistical areas (MSAs) across the country. The current definition is as of November 2004. The general concept of an MSA is that of a large population nucleus combined with adjacent territory that has a high degree of economic and social integration with that nucleus as measured by community ties.

Along with these changes to the geographic definition of the MSAs, our study defined life sciences regions by combining some MSAs, eliminating or even adding some counties (since clusters rarely conform to the official MSA definition). If an MSA had a high degree of life science linkages and interaction with another MSA—essentially operating as one cluster—we combined the two MSAs and referred to the new geographic area as "Greater."

Greater Los Angeles is a good example. Our study combined the two metropolitan statistical areas of Los Angeles–Long Beach–Santa Ana, California, and Oxnard–Thousand Oaks–Ventura, California, dubbing the combined region "Greater Los Angeles." Our definition takes into account that both MSAs form a geographic concentration of interconnected companies and institutions in the life sciences. For example, Amgen, one of the world's largest biotechnology companies, is located in the Oxnard–Thousand Oaks–Ventura MSA, but it has strong ties to suppliers of specialized inputs and governmental and other institutions in the Los Angeles–Long Beach–Santa Ana MSA. In fact, Amgen's headquarters and related operations are within a couple of miles of the Los Angeles County border.

Likewise, removing Middlesex County, New Jersey, from the New York–Northern New Jersey–Long Island, NY-NJ-PA MSA is intended to stress the fact that Middlesex County, with its resources in life sciences R&D and a large pool of life science–related venture capital funds, qualifies as a small life sciences cluster on its own. The life sciences cluster in Middlesex County benefits from its efficient infrastructure, strong base of supporting functions and institutions, and a great supply of well-trained employees. Neither New York nor Philadelphia has the gravitational pull or interconnections to claim Middlesex County as part of their respective life sciences clusters.

Including Mercer County, New Jersey (the Trenton MSA), in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA reflects the strong linkages between the life sciences companies in these locations. The presence of multiple suppliers and institutions assists in knowledge creation as well as efficient access to specialized inputs, services, and employees. The relationship reflects the fundamental influence of externalities and linkages across firms and associated institutions in Greater Philadelphia's life sciences industry. This extends the cluster to include Princeton, New Jersey.

The table on the following page provides a list of the eleven life sciences regions, studied with their official OMB definitions and detailed information on the counties they encompass. These metro regions include: Greater San Francisco, Greater New York, Greater Raleigh-Durham, Greater Los Angeles, San Diego, Washington, D.C., Chicago, Seattle, Minneapolis, and Boston. Essentially, these regions have either similar industry bases or development histories (peer regions) or are considered leading regions.

Definitions of metropolitan statistical areas

Life science region	Official metro name, defined by OMB	Counties		
Boston	Boston-Cambridge-Quincy MA-NH MSA	Norfolk, MA Plymouth, MA Suffolk, MA	Essex, MA Rockingham, NH Strafford, NH	Middlesex, MA
Chicago	Chicago-Naperville-Joliet, IL-IN-WI MSA	Cook, IL De Kalb, IL Du Page, IL Grundy, IL Kane, IL	Kendall, IL McHenry, IL Will, IL Jasper, IN Lake, IN	Newton, IN Porter, IN Lake, IL Kenosha, WI
Greater Raleigh Durham	Raleigh-Cary, NC MSA Durham, NC MSA	Franklin, NC Johnston, NC Wake, NC	Chatham, NC Durham, NC Orange, NC Person, NC	
Greater Los Angeles	Los Angeles-Long Beach-Santa Ana, CA MSA Oxnard-Thousand Oaks-Ventura, CA, MSA	Los Angeles, CA Orange, CA	Ventura, CA	
Minneapolis	Minneapolis-St. Paul-Bloomington MN-WI MSA	Anoka, MN Carver, MN Chisago, MN Dakota, MN Hennepin, MN	Isanti, MN Ramsey, MN Scott, MN Sherburne, MN Washington, MN	Wright, MN Pierce, WI St. Croix, WI
Greater New York	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (excludes Middlesex, NJ)	Monmouth, NJ Ocean, NJ Somerset, NJ Nassau, NY Suffolk, NY Bergen, NJ Hudson, NJ	Passaic, NJ Bronx, NY Kings, NY New York, NY Putnam, NY Queens, NY Richmond, NY	Rockland, NY Westchester, NY Essex, NJ Hunterdon, NJ Morris, NJ Sussex, NJ Union, NJ Pike, PA
Greater Philadelphia	Philadelphia-Camden-Wilmington PA-NJ-DE-MD MSA Trenton, NJ MSA	Burlington, NJ Camden, NJ Gloucester, NJ Bucks, PA	Chester, PA Delaware, PA Montgomery, PA Philadelphia, PA	New Castle, DE Cecil, MD Salem, NJ Mercer, NJ
San Diego	San Diego-Carlsbad-San Marcos, CA MSA	San Diego, CA		
Greater San Francisco	San Francisco-Oakland-Fremont, CA, MSA San Jose-Sunnyvale-Santa Clara, CA, MSA	Alameda, CA Contra Costa, CA Marin, CA San Francisco, CA San Mateo, CA	San Benito, CA Santa Clara, CA	
Seattle	Seattle-Tacoma-Bellevue, WA MSA	King, WA Snohomish, WA Pierce, WA		
Washington, D.C.	Washington -Arlington-Alexandria, DC-VA-MD-WV, MSA	Alexandria City, VA Calvert MD Charles, MD Clarke, VA Loudoun, VA Manassas City, VA Manassas Park, VA	District of Columbia Fairfax City, VA Fairfax, VA Falls Church City, VA Montgomery, MD Prince Georges, MD Prince William, VA Spotsylvania, VA	Fauquier, VA Frederick, MD Fredericksburg City, VA Jefferson, WV Stafford, VA Warren, VA

Sources: U.S. Census, Office of Management and Budget, Bureau of Economic Analysis.

Multiplier Impacts in Greater Philadelphia

Background and Relevance

The life sciences sector in Greater Philadelphia provides significant value to local residents and an enormous amount of wealth to the region overall. Its economic contribution to the region goes well beyond simply direct impacts, which include the jobs it generates, the earnings it provides to workers, and the output it creates. In order to capture the full contribution of the economic impacts stemming from the industry and its location, we apply unique coefficients, known as "multipliers," to the specific life sciences industries.[1]

Multipliers enable us to quantify how employment, earnings, and output generated by a specific industry within a region ripple through and impact other economic sectors in that region. In addition to providing data on an industry's broader impact, economic multipliers also bring to light region-wide interdependencies and inter-industry relationships.

The extent of such an impact is typically determined by analyzing the length and characteristics of the supply chain throughout the region. If an industry has a longer and higher-quality supply chain, it has a greater overall impact in its region. Pharmaceutical and biotech manufacturing has one of the highest employment multipliers in the region and is high across the country. The industry requires a larger proportion of highly skilled and specialized labor, including many scientists and researchers. Subsequently, this need draws a higher demand for supply-related goods and services, which are likely to stem from the same region.

Supplier industries, outside contractors, and other business catering directly to the life sciences are part of this tightly knit network. Their presence is a key part of the industry's **indirect** impacts. They, in turn, utilize the goods and services of other businesses in the region, further stimulating the economy. Many jobs created in the wholesale and retail trade sector, services, and construction, for example, are created indirectly in this fashion.

The supply chain activity generates yet more income for the region's residents, who in turn recycle it back into the economy. For example, in addition to consumer spending by biochemists, microbiologists, and doctors, one should also consider spending by other business professionals, restaurant workers, retail clerks, real estate agents, and many others who are indirectly supported by the existence of life sciences firms. These consumption effects are termed **induced** economic impacts.

In this section we have identified not only the direct impacts created by the life sciences in terms of jobs, earnings, and output, but also the broader economic activity generated by the sector.

Metro Findings

In 2007, the life sciences sector in Greater Philadelphia employed 94,400 workers, including those who provide health-care services consumed by non-residents. Out of that total, nearly 60 percent (or 56,300 jobs) stem from therapeutics and devices: namely pharmaceuticals and biotech manufacturing, medical devices manufacturing, and life science–related R&D. The remaining 40 percent consist of health-care service jobs that were generated through export-driven activity outside the region. Since some of these services would already be consumed locally, we do not include the entire spectrum of health-care services employment in the region. In determining

1. Through their RIMS II program, the Bureau of Economic Analysis (BEA) assigns multiplicative values to regional industries.

the portion of health-care services not consumed locally, we examine the relevant location quotients from our current impact assessment.[2]

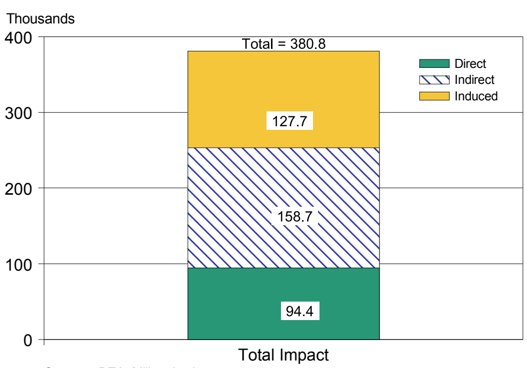
The region's life sciences sector generated $7.7 billion in earnings and $17.5 billion in output or gross metro product (GMP) in 2007. The therapeutics and devices segment accounts for the largest share of the earnings and output created by the overall sector.

After accounting for the multiplier impacts, the life sciences sector in Greater Philadelphia is responsible for 380,800 jobs, $20.2 billion in earnings, and $39.7 billion in output based upon 2007 information. In other words, the life sciences both directly and indirectly drive roughly 15 percent of all economic activity in the region. Furthermore, one out of every six jobs in Greater Philadelphia can be traced back to the life sciences.

The chart below on the left explains the breakdown of the total life sciences impacts in Greater Philadelphia once the multiplicative dynamics have been taken into account. On top of direct employment, an additional 286,400 total jobs are generated as a result of the life sciences; 158,700 are created indirectly and another 127,700 arise from induced impacts.

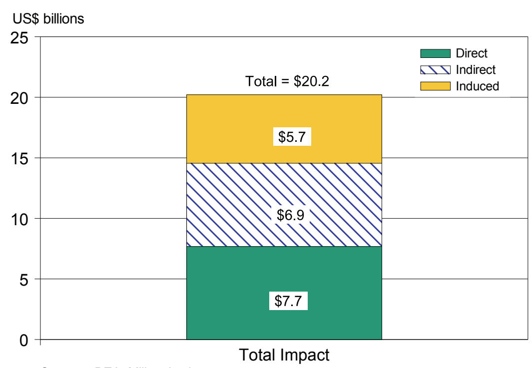
In other words, for every job created in the region's life sciences sector, three additional jobs are created elsewhere. Similarly, in terms of earnings, an additional $12.6 billion dollars is created after filtering through other sectors.

Total impact of Greater Philadelphia life sciences
Employment, 2007



Sources: BEA, Milken Institute.

Total impact of Greater Philadelphia life sciences
Earnings, 2007



Sources: BEA, Milken Institute.

The following tables provide a breakdown of total life sciences impacts according to their specific industry classifications. While health-care services comprise the biggest impact in terms of the direct employment, the manufacturing of pharmaceuticals generates the greatest impact once the multiplicative dynamics ripple through various sectors of the economy. Not only does pharmaceutical manufacturing comprise 28 percent of the direct impacts, but due to its high multiplier, pharmaceuticals also account for 51 percent of the total impacts. At 7.3,

2. The existence of therapeutics and devices alone creates economic activity throughout the health-care services sector that would be consumed locally. Therefore, applying the multiplier to therapeutics and devices would result in jobs, earnings, and output created in health-care services. However, it would not account for the incremental activity brought on by demand from outside the region. To do this, we take the location quotient for the relevant health-care industries. If the LQ exceeds 1.0 for any given health-care industry in the region, we calculate only the portion that exceeds the national average. If we were to apply the entire health-care service employment in the region to its respective multiplier, we would be effectively double-counting.

the employment multipliers for biotech and pharmaceuticals are the highest among the life sciences sector, and is among top ten highest among all industry multipliers in the region. For every job in the pharmaceutical industry, another six jobs are created elsewhere in the region.

Multiplier impacts on employment

Greater Philadelphia, 2007

	Direct-effect employment multiplier	Total impact (Thousands)	Direct impact (Thousands)	Indirect + induced (Thousands)
Biotech	7.3	27.0	3.7	23.3
Pharmaceuticals	7.3	192.8	26.4	166.4
Medical devices	3.6	24.0	6.7	17.3
R&D	2.8	54.0	19.5	34.6
Health-care services*	2.2	83.0	38.1	44.8
Total life sciences	4.0	380.8	94.4	286.4

Sources: BLS, BEA, Milken Institute.

Includes only portion of health-care services not consumed locally (exported outside the region).

Although the health-care services segment has the smallest multiplier within the larger life sciences sector, the industry overall employs 283,000 workers. The industry accounts for various health-care practitioners, specialty hospitals, and home health-care services. The region's world-renowned health-care facilities attract many patients from outside the immediate region, including some who travel here from abroad to seek treatment. To separate out this effect, we apply the multiplier to this portion, or about 13.5 percent of the industry base. Roughly, 38,100 employees in the region's health-care service industry are brought on to meet demand outside the region. Their contribution, in turn, creates an additional 44,800 jobs in other sectors.

The region's entire life sciences sector has an earnings multiplier of 2.6, suggesting that for every dollar it produces, an additional $1.60 in earnings is generated in other sectors. After these effects ripple through all sectors, the life sciences were accountable for producing approximately $20.2 billion across all sectors in the region. With an earnings multiplier of 3.6, pharmaceuticals capture almost half (48 percent) of the total earnings impact, the greatest contribution among life sciences industries.

Multiplier impacts on earnings

Greater Philadelphia, 2007

	Direct-effect earnings multiplier	Total impact (US$M)	Direct impact (US$M)	Indirect + induced (US$M)
Biotech	3.6	$1,347	$376	$971
Pharmaceuticals	3.6	$9,591	$2,676	$6,915
Medical devices	3.5	$1,442	$411	$1,031
R&D	1.8	$4,268	$2,343	$1,926
Health-care services*	1.9	$3,553	$1,858	$1,695
Total life sciences	2.6	$20,201	$7,663	$12,538

Sources: BLS, BEA, Milken Institute.

Includes only portion of health-care services not consumed locally (exported outside the region).

In 2007, the average annual earnings figure across the life sciences sector was $81,200 (varying from health-care services, with an average annual pay of $48,000, to R&D at $120,000). The average annual earnings across all industries in the region was approximately $50,800 in that year.

While most of the additional jobs that were created (indirect and induced) generated annual earnings just below the industry average, those stemming from medical devices and life sciences R&D produced relatively higher annual wages (closer to $60,000 on an average annual basis). So while pharmaceuticals account for the greatest impact in absolute terms, industries that support medical devices and R&D carried relatively higher value.

In terms of direct-effect multipliers (see the "Methodology" section at the end of this chapter for a definition), R&D multipliers tend to be smaller in size since the extent of their impact is not as widespread. Conversely, manufacturing of pharmaceutical products is more likely to have an immediate impact in other sectors at each stage of the value chain. For example, prior to entering the market, these products must endure several rounds of clinical trials, which induce more economic activity. While the development phase may take several years, rising R&D costs absorb much of the revenue stream.

In terms of output, the multipliers are fairly close across most of the life sciences sectors. In general, for every dollar of output produced with the life sciences, an additional $1.30 is created in other sectors within the region. In 2007, life sciences in the region were responsible for creating nearly $40 billion worth of output after rippling through other sectors. Of this amount, the pharmaceuticals industry in Greater Philadelphia comprised 56 percent of the total life sciences impact.

Multiplier impacts on output

Greater Philadelphia, 2007

	Total output multiplier	Total impact (US$M)	Direct impact (US$M)	Indirect + induced (US$M)
Biotech	**2.3**	**$3,148**	**$1,396**	**$1,752**
Pharmaceuticals	**2.3**	**$22,081**	**$9,794**	**$12,287**
Medical devices	**2.1**	**$990**	**$461**	**$529**
R&D	**2.3**	**$7,309**	**$3,196**	**$4,114**
Health-care services*	**2.4**	**$6,169**	**$2,603**	**$3,566**
Total life sciences	**2.3**	**$39,697**	**$17,450**	**$22,247**

Sources: BLS, BEA, Milken Institute.

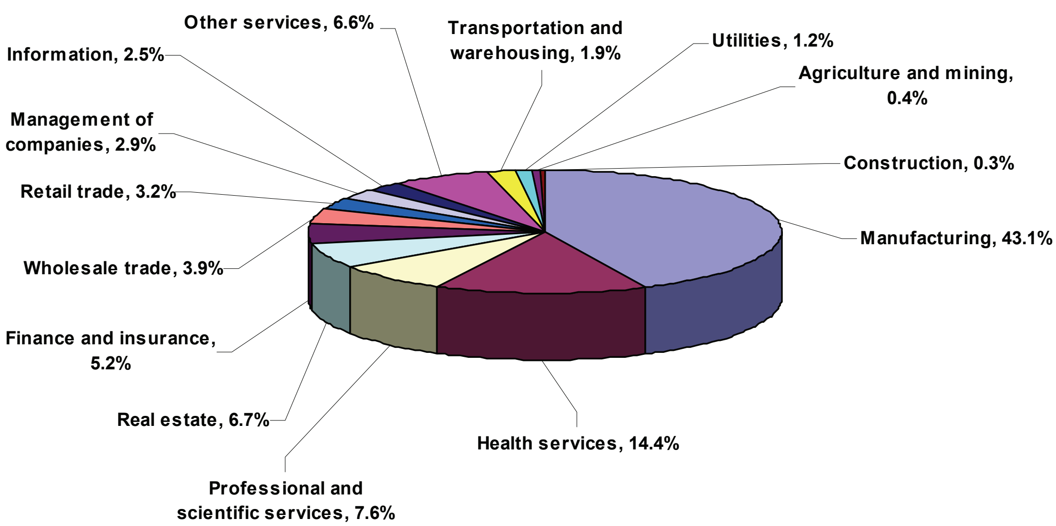
**Includes only portion of health-care services not consumed locally (exported outside the region).*

On average, the life sciences produced $185,000 in output per employee in 2007, almost twice as high as the average output ($102,000) generated per employee across all industries. Due to its value-added nature at each stage of production, output per employee stemming from the region's biotech and pharmaceuticals industries came in at $377,000 and $370,000, respectively. Furthermore, the additional jobs created through these industries generated an output per employee of $77,000 on average. The additional jobs stemming from life science–related R&D services generated output per employee of $119,000 a year on average. Jobs supporting such value-added industries also tend to produce high levels of output, which translates into greater wealth for the region's residents.

The pie chart below illustrates how the total economic impact stemming from the life sciences is distributed across all industries. To fully appreciate the economic implications of jobs in the pharmaceutical or medical device fields, for instance, it is critical to understand which sectors in the region are impacted most by life sciences. While 43.1 percent of the impacts are allocated across various manufacturing sectors, health-care services and many other industries that support the life sciences also account for a significant share of the additional economic activity. Engineering and architectural services, testing laboratories, and wholesale distribution of pharmaceutical products are only a few industries that benefit from the life sciences. Professional and business-related services account for 7.6 percent of the additional economic activity, followed by real estate and financial activities, with 6.7 and 5.2 percent, respectively. Trade and management-related services together account for another 10 percent of the total impacts.

Economic activity generated by the life sciences sector

Greater Philadelphia, 2007



Sources: BEA, Milken Institute.

Clearly, economic activity stemming from the life sciences not only creates wealth in other sectors but also creates the opportunities necessary for long-term economic prosperity. The Greater Philadelphia area as a whole benefits significantly from such a valuable asset, particularly one that is based on attracting talented, high-skilled labor and is driven by innovation.

Methodology

The Milken Institute utilized the Regional Input-Output Modeling System (RIMS II) developed by the Bureau of Economic Analysis (BEA) at the U.S. Department of Commerce to conduct its systematic economic multiplier impact analysis. The RIMS II structure is based on an input-output framework of U.S. industries and is often used to estimate the total impact that one industry has on the wider economy.

The appropriate industry multipliers from RIMS are applied to the employment, earnings, and output estimates (or direct impacts) compiled from the Bureau of Labor Statistics (BLS). The input-output matrix from RIMS provides the necessary coefficients or multipliers needed to estimate the total number of jobs or the value of wealth generated by the life sciences in other sectors of the economy. Thus, the total impact is calculated by applying the multiplier to the direct impact for employment, earnings, and output. Further statistical estimation is conducted to derive the difference between the induced and indirect shares.

The employment and earnings multipliers are based on a direct-effect concept. In other words, these multipliers quantify how life sciences employment and earnings directly impact employment and earnings across all industries. More specifically, the direct-effect employment multiplier measures the change in the number of jobs in all industries that result from a change of one job in the life sciences industry. Similarly, the direct-effect earnings multiplier calculates the total dollar change in the earnings of households employed by all industries that results from a $1 change in earnings paid directly to households employed by the life sciences industry.

Finally, the output multiplier is based on a final-demand concept. It measures the total dollar change in output in all industries that results from a $1 change in output delivered to final demand by the life sciences industry. The final demand concept excludes the impact of intermediate purchases of goods and services. In other words, it does not fully reflect the impact at each stage of production, thereby resulting in a lower coefficient (or multiplier) relative to employment and earnings.

BEA multipliers are based on 2006 regional data and are derived from 1997 U.S. annual I-O matrix. Industries for which multipliers are available are based on the North American Industry Classification (NAICS) system as defined by the Office of Management and Budget. The industries for which multipliers were carried out included the following NAICS codes: 3254 (for pharmaceuticals and biotech); 334510, 334517, and 339112-16 (for medical devices); and 5417 (for R& D in the life sciences); 621, 6216, 622, and 623 (for the relevant health-care service industries). Since RIMS does not provide further detail on NAICS code 3254, we assume that pharmaceuticals and biotech share the same multiplier.

Innovation Pipeline

A vibrant and competitive life sciences industry must be supported by a strong and efficient innovation pipeline, which is composed of economic elements that facilitate the industry's technological innovation and production. We have analyzed the innovation pipeline of Greater Philadelphia with a view toward determining its capacities to generate and commercialize ideas, research, and health advances, relative to other leading centers.

Components of the Index

As in our previous study on Greater Philadelphia's life sciences cluster,[1] the innovation pipeline consists of five components:

• **Research and development (R&D) capacity:** A region's research and development capacity can be referred to as its knowledge assets. These are essential to a region's ability to commercialize innovation. The transfer process to the market is facilitated by universities, institutes, and firms through investments in R&D. Commercial success, along with remunerations received, is underpinned by the quality of the innovations in a given region.

• **Risk capital and entrepreneurial infrastructure:** Startups, key companies, entrepreneurs, and the ecosystem of collaborating agents constitute the entrepreneurial infrastructure of a region. Venture capital is essential to business development and growth. Together, these elements reflect how conducive a region is to life sciences business development from an innovation standpoint.

• **Human capital:** The human capital component depicts a region's ability to produce, retain, and attract talent and to nurture and develop a highly skilled workforce. To excel in knowledge-intensive sectors such as the life sciences, a region must be able to establish a strong capacity to produce a flow of human capital. In a knowledge-driven economy, the ability to increase and regenerate human capital becomes even more critical to a region's growth and competitiveness.

• **Workforce:** A skilled workforce is the finished product of human capital formation. The competitive advantage of a region's knowledge-based industry depends on its ability to leverage talent to support the commercialization and production of innovation. A high concentration of various relevant skilled professionals enhances a region's ability to innovate and produce products and services.

• **Innovation output:** This component captures the ability of a region to leverage its various life sciences assets. One major example is new drug development, including the approval and commercialization processes, which are often protracted and expensive. Critical inventions are usually patented and commercialized, bringing returns to the licensees. In sum, this component reflects a region's ability to capture the results from its R&D efforts, with better results implying better inventions.

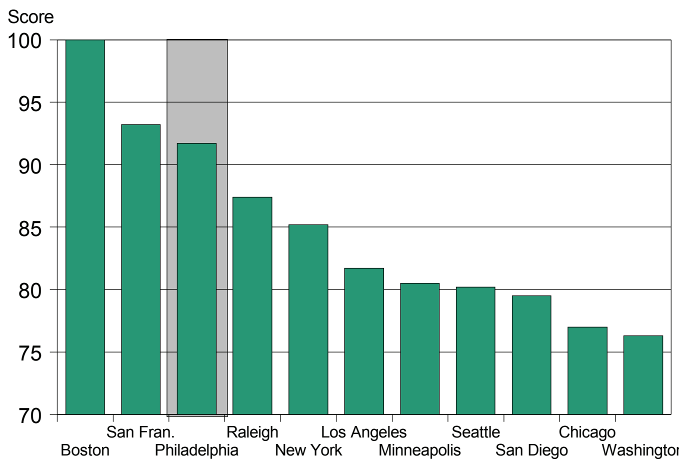
1. Ross DeVol et al., *The Greater Philadelphia Life Sciences Cluster* (Milken Institute, 2005).

Innovation Pipeline Index: Results

The following graph and table depict Greater Philadelphia's life sciences innovation pipeline compared to the ten other benchmarked metros. The composite score of each metro is illustrated in the table below. The results show that Greater Philadelphia retained its 2005 rank of 3rd place, just behind Boston and San Francisco. It is noteworthy, however, that Greater Philadelphia largely closed the gap that previously existed with 2nd-place San Francisco.

Innovation Pipeline Composite Index

Selected metropolitan regions, 2009



Source: Milken Institute.

Innovation Pipeline Index

Composite scores, 2009

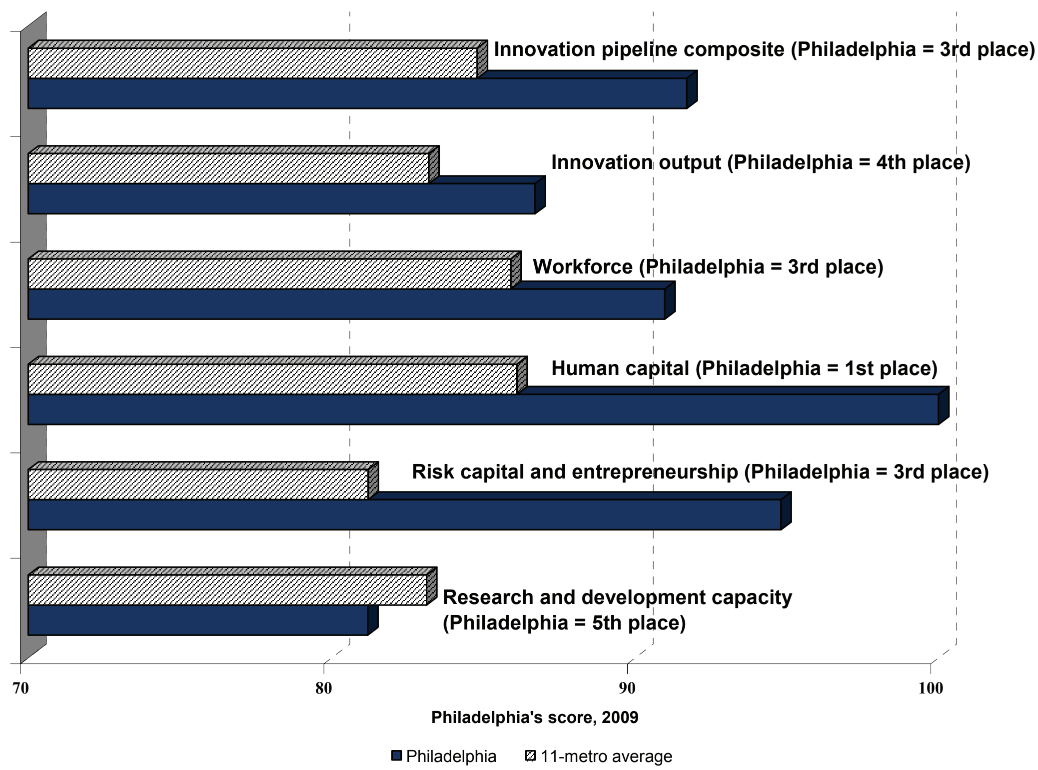
Rank	Metro	Composite score
1	Boston	100.0
2	Greater San Francisco	93.2
3	**Greater Philadelphia**	**91.7**
4	Greater Raleigh-Durham	87.4
5	Greater New York	85.2
6	Greater Los Angeles	81.7
7	Minneapolis	80.5
8	Seattle	80.2
9	San Diego	79.5
10	Chicago	77.0
11	Washington, D.C.	76.3

Boston and San Francisco were also the top two metros in our 2005 study. Remarkably, however, Greater Philadelphia has sprung into the top percentile in this study; in the previous edition, only Boston and San Francisco posted scores above 90 points. The five metros that follow in the rankings fall within the 80–90 point range: Greater Raleigh-Durham, Greater New York, Greater Los Angeles, Minneapolis, and Seattle. The final three metros in our group (San Diego, Chicago, and Washington, D.C.) scored above 75 but below 80 points. It is important to note that these index points must be interpreted in relative terms among the eleven selected metros.

The following graph illustrates Greater Philadelphia's performance in each of the five innovation pipeline components, as well as its overall performance (shown in the top bar). Consistent with the preceding discussion, Greater Philadelphia's overall score of 91.7 points is well above the eleven-metro average score of 85 points.

Innovation Pipeline Index composite scores

Greater Philadelphia's scores, 2009



Once again, Greater Philadelphia's strength in the life sciences is evident from its high ranking and score. The foundation for its performance is firmly established in four of the five components. With the exception of research and development capacity, Greater Philadelphia performed substantially better than the eleven-metro average.

Particularly in the components focused on human capital and risk capital, Greater Philadelphia excelled by scoring more than 10 points above the eleven-metro average. With its rich human capital base, Greater Philadelphia outperformed the ten other metros by a large margin. Its world-class universities also lay the foundation to attract venture capital. Two related components—innovation output and workforce—stem directly from Greater Philadelphia's knowledge base and assets. With improved venture capital support and leading universities specializing in the life sciences, it is not surprising to see the region excel in innovation output and life sciences workforce.

Although Greater Philadelphia did not perform as well in R&D capacity, its strength in the other components enabled the region to maintain its lofty status at 3rd position. Increasing its R&D capacity is an opportunity for the region to leverage its strengths in other areas to boost its overall innovation pipeline.

The sections that follow offer a more detailed discussion of each component and its respective measures.

Research and Development Capacity

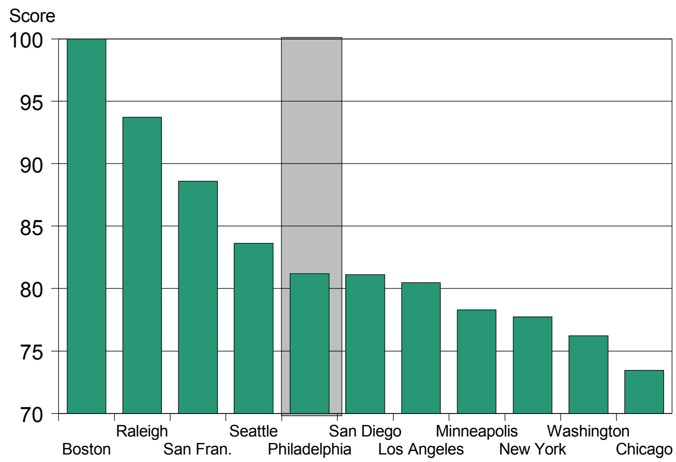
Research and development (R&D) capacity forms an integral component of a region's innovation pipeline. It reflects a region's ability to attract key industry players, develop regional strengths, and, ultimately, build industry clusters. Because the life sciences are a knowledge-based industry, research and development assets are the engines that drive technological innovation and growth. Data and analysis on R&D assets were compiled using nine measures:

R&D capacity measures	**Definitions**
Academic R&D funding in life sciences	Academic R&D depicts the importance of university research and the R&D capacity of a region's university system. Because it is focused on basic rather than applied research, academic R&D is particularly important to industry sectors such as biotech, in which research activities tend to involve early stages of biopharmaceutical commercialization.
Industry R&D funding in life sciences	Industry expenditures are the largest financial support for life sciences R&D. This measure is therefore a key element in the industry's innovative capacity and competitiveness.
NSF research funding in life sciences Competitive NSF funding rate in life sciences	The National Science Foundation (NSF) is a key public investor in science and technology. With its stringent requirements, its allotment of research funding reflects the quality of research conducted by applicants. We use two different measures regarding NSF funding to show the life sciences R&D presence in each of the eleven metros.
Number of STTR awards to life sciences firms STTR award dollars to life sciences firms Number of SBIR awards in life sciences firms SBIR award dollars in life sciences firms	The number and value of Small Business Technology Transfer (STTR) and Small Business Innovation Research (SBIR) awards reflect the strength of innovation, technology commercialization, and entrepreneurship. In this study, we used four measures based specifically on these awards to analyze the life sciences R&D presence in each region.
NIH funding	The National Institutes of Health (NIH) is part of the U.S. Department of Health and Human Services. It is the largest single funding agency in the life sciences arena. Unlike our methodology in the 2005 study, we combined three individual NIH funding items into a single measure. The level of NIH funding is also a good reflection of the quality of life sciences R&D in a given region.

An overall component for R&D capacity was computed as a composite of all nine measures. The findings show that Greater Philadelphia ranked 5th among the eleven benchmarked metros. It placed behind Boston, Greater Raleigh-Durham, Greater San Francisco, and Seattle, as shown in the following graph.

Life sciences research and development

Selected metropolitan regions, 2009



Source: Milken Institute.

It must be noted that Greater Philadelphia maintained its 2005 position in this component. However, the differences in scores were larger than in the previous study. This means that the top metros (Boston, Raleigh, and San Francisco) have increased their R&D capacity substantially since the last study, relative to Greater Philadelphia.

The leadership of Boston and Greater Raleigh-Durham stems from a high concentration of hospitals, medical centers, and top universities. Boston's leadership in R&D assets is no surprise, since it is home to renowned medical centers and prestigious universities. Among its top employers are Brigham and Women's Hospital, Massachusetts General Hospital, and Tufts/New England Medical Center, which each have more than 5,000 employees.[2] Harvard and MIT are key regional assets that attract life sciences R&D funding.

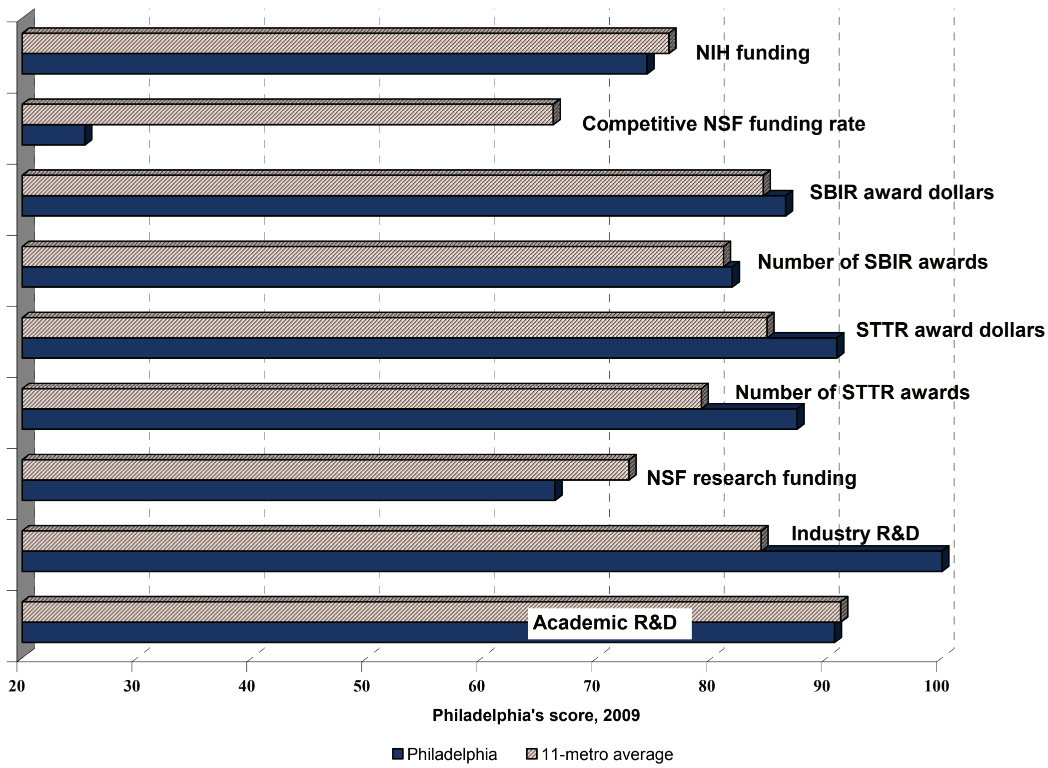
In Greater Raleigh-Durham, GlaxoSmithKline, a research-based pharmaceuticals company, employs almost 10,000 workers.[3] Together with leading educational institutions such as Duke University, the nearby University of North Carolina–Chapel Hill, and North Carolina State University, its research base serves as an attraction to R&D funding in the life sciences.

Greater Philadelphia's performance in each of the individual R&D capacity measures is illustrated in the chart on the following page. Greater Philadelphia's bar reflects its rebased score (out of 100), and the corresponding eleven-metro-average bar reflects the rebased score of its peers.

2. Moody's Economy.com, Metro Précis Boston.

3. *Triangle Business Journal Book of Lists 2008* (American City Business Journals, 2008).

Greater Philadelphia's life sciences R&D capacity scores
2009



The findings show that Greater Philadelphia excelled in industry R&D, scoring well above the eleven-metro average score. This strength stems from the region's rich assortment of pharmaceutical firms, as well as those specializing in biotech and devices. Due to the unique therapeutic and device innovation milieu in the region, massive industry R&D funding pours in. New York, Boston and San Francisco came in close behind, in 2nd, 3rd, and 4th places, with rebased scores of 93, 91, and 90 points respectively.

As shown in the graph above, in all four measures related to STTR and SBIR awards, Greater Philadelphia's performance was slightly better than the average performance of all eleven metros, with rankings falling between 3rd and 5th (see the Appendix for detailed tables). This represents an important sign of improvement for the region, since it ranked anywhere from 6th to 8th on these measures in our 2005 analysis. This helps bolster the area's pre-seed, proof-of-concept funding, without which many good ideas die on the vine. These findings suggest Greater Philadelphia's enhanced position in churning out high-quality innovation.

Similar to the findings in 2005, Greater Philadelphia was weakest in terms of NSF funding received for life sciences R&D. Out of 103 proposals submitted from the region, NSF awarded funding to only fourteen, resulting in a success rate of approximately 14 percent. In contrast, Boston (the top-ranked metro in this measure) had an NSF funding rate of 27 percent, with forty-six proposals accepted.

Greater Philadelphia has opportunities for growth if it can further leverage the abundant human capital from its world-class universities. Comparing the region to Greater Raleigh-Durham and Boston, Greater Philadelphia certainly possesses similar R&D assets, given the prominent presence of Merck and Company Inc., the University of Pennsylvania, and large hospitals like the Thomas Jefferson University Hospitals. By building on these assets, Greater Philadelphia can strengthen its R&D base and pursue higher amounts of funding for R&D in the form of NSF and NIH grants, as well as SBIR and STTR awards. The life sciences cluster in Greater Philadelphia is dependent on the opportunities that arise from these assets. The following sections will show that these are key strengths that underpin the region's excellence in life sciences innovation.

Supporting Technology Transfer and Entrepreneurship

Greater Philadelphia has a robust infrastructure that supports the transfer of innovations in the life sciences to the marketplace.[4] Indeed, beginning entrepreneurs find the region especially attractive because of the variety of groups and organizations that facilitate this process.

Keystone Innovation Zones

Keystone Innovation Zones (KIZ) were created by the state of Pennsylvania to promote technology transfer and entrepreneurship. Six KIZs are based in southeastern Pennsylvania, and four of these have a life sciences focus. For example, the Chester County KIZ was set up in January 2007 to focus on life sciences, biotechnology, and information technology. It provides companies with several services such as:

- connections to accounting services
- funding resources
- human resource benefits
- legal experts
- internship connections
- subsidies for training grants
- real-estate support[5]

First State Innovation

First State Innovation (FSI) is a nonprofit organization led by the private sector to facilitate entrepreneurship in Delaware and the surrounding region. With a list of more than 150 angel investors, FSI serves as the connector to help entrepreneurs raise money. Their novel approach includes regular social sessions in which entrepreneurs and investors can meet, network, and share ideas.[6]

Methodology

The nine components were given equal weight to compute a total score for R&D presence in each region. Data were collected for each region and rebased according to the number of businesses, gross metro product (GMP), and population for comparison. After logarithmic transformations, the final scores and ranks were based on both absolute and rebased scores.

The National Science Foundation (NSF) and the National Institutes of Health (NIH) were major data sources in this component. Data on population and GMP for each region were collected from Moody's Economy.com. A summary of data sources can be found at the end of this chapter.

4. Susan Brown, "Ramping Up Tech Transfer," The Scientist, http://www.the-scientist.com/2008/01/01/s42/1/.
5. Mike May, "Keystone Innovation Zones," The Scientist, http://www.the-scientist.com/2008/01/01/s30/1/.
6. Ibid.

Risk Capital and Entrepreneurial Infrastructure

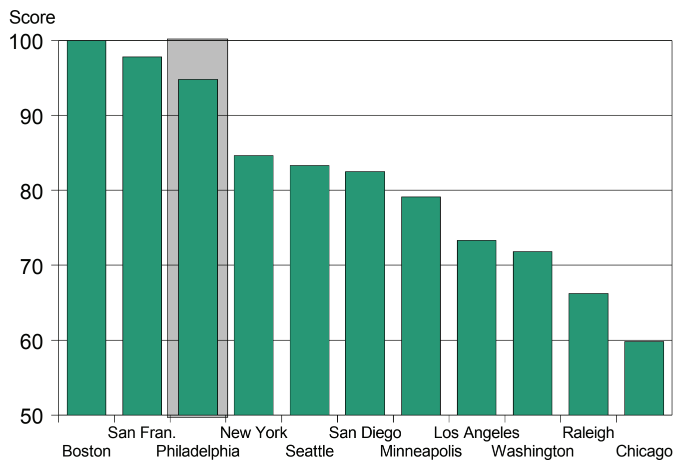
Entrepreneurship and innovation are important drivers of a life sciences cluster. The dynamics of creativity in a region and the sophistication of its entrepreneurs are reflected in the amount of risk capital it attracts. Data and analysis on risk capital and entrepreneurial infrastructure were executed using seven measures that reflect the ability of a region to bring new ideas to the market. The following table illustrates the seven individual component measures used to operationalize risk capital and entrepreneurship measures in this study.

Risk capital and entrepreneurial infrastructure measures	**Definitions**
Life sciences VC investment Life sciences VC investment growth Number of companies receiving VC investments Growth in life sciences companies receiving VC investments	Venture capital (VC) is measured using four component measures. Through VC, investors single out up-and-coming businesses that demonstrate potential for high returns on investment for their products or services. In this study, we look at both the absolute value of these investments as well as the growth of this funding over a five-year period. In addition to the amount of VC invested, we also looked at the number of companies that received these investments as well as their corresponding growth over a five-year period. These measures account for regions that have VC spread out over several companies rather than a few large ones.
Academic degrees awarded in entrepreneurship	Some universities offer degree programs in entrepreneurship. This measure captures the number of such degrees awarded in a region.
Business starts in life sciences	Business starts reflect a region's entrepreneurial environment. They also underline its job creation capacity.
Tech Fast 500 companies in life sciences	Technology Fast 500 companies are North America's fastest-growing technology firms in terms of revenue growth over the course of five years (in this case 2003 to 2007). This list is compiled annually by Deloitte & Touche. These companies show promise for delivering long-term technological and economic impact. In this measure, we focus on companies within the list that are focused on the life sciences.

An overall component for risk capital and entrepreneurial infrastructure was computed as a composite capturing all seven measures. The findings show that Greater Philadelphia ranked 3rd among the eleven metros, behind Boston and San Francisco, as shown in the following graph. Of note, these three metros are the only ones that scored above 90 points in this component. Although Greater Raleigh-Durham and Seattle were ahead of Greater Philadelphia in terms of life sciences R&D capacity, neither of these metros performed as well in risk capital and entrepreneurship.

Life sciences risk capital and entrepreneurship

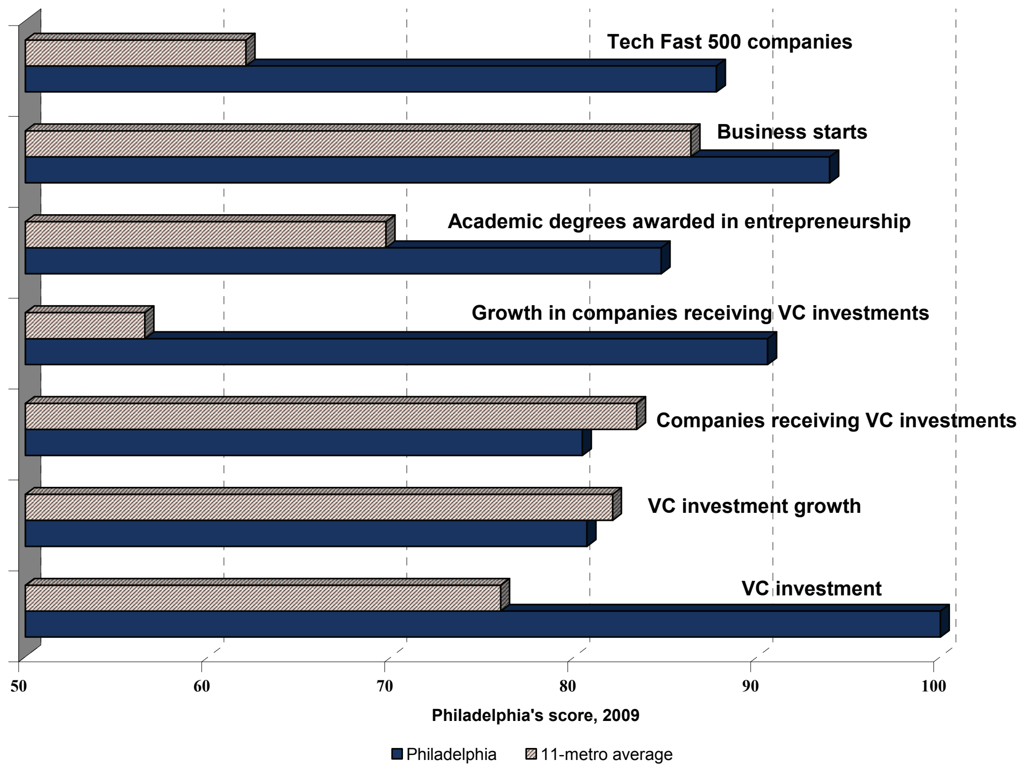
Selected metropolitan regions, 2009



Source: Milken Institute.

The following graph illustrates Greater Philadelphia's performance in each of the seven measures that make up the risk capital and entrepreneurial infrastructure component compared to the eleven-metro average.

Greater Philadelphia's life sciences risk capital and entrepreneurial infrastructure scores
2009



Looking at these individual scores, we see that Greater Philadelphia performed very well in two measures in particular. Its highest relative performance (ranked 1st) was in life sciences venture capital investment, a category in which it outperformed the other ten metros by a wide margin. This is a remarkable advance from Greater Philadelphia's 8th-place ranking in our 2005 analysis. Much effort has been applied by the region's leadership to cultivate a wide network of financial agents to attract more VC activity. Greater Philadelphia also had a higher-than-average concentration of Tech Fast 500 companies in the life sciences, winning the 3rd position in this measure. In 2008, approximately 36 percent of all venture capital funding in Greater Philadelphia went to life sciences industries, closely matching the average share of all eleven metros. By comparison, the life sciences share of VC investments in Boston was 45 percent in 2008.

In terms of entrepreneurship degrees awarded, Greater Philadelphia, although ranked 5th, performed better than the other metros on average. The region also saw considerable growth in companies receiving life sciences venture capital investments, but was ranked 5th in this measure. The same finding applies to life science business starts, where the region was ranked 8th among all eleven metros. In these two measures, some metros fared poorly, boosting Greater Philadelphia's performance on a relative basis.

In terms of life sciences venture capital growth, the number of companies receiving VC investments, and the number of entrepreneurship degrees conferred, Greater Philadelphia (ranked 7th) came in slightly below the eleven-metro average performance. Based on these findings, it can be inferred that although Greater Philadelphia's life sciences cluster remains a magnet for venture capital investments, other locations are emerging to compete for capital. In the long run, Greater Philadelphia must continue to leverage its strengths to grow its life sciences base so as to accommodate and retain new businesses in this sector.

Greater Philadelphia's strength in the life sciences is well-established; it has built a reputation for leading medical centers and cutting-edge research. However, its high business costs and outward migration trends may hinder the future growth of industry innovation. Risk capital and entrepreneurship in the region can be further boosted with strategies that take advantage of its existing life sciences assets.

From the findings, it appears that Greater Philadelphia's risk capital and entrepreneurship landscape has hidden opportunities for growth. While there are well-established companies that are already attracting and absorbing venture capital, small startups can take better advantage of the life sciences cluster—that is, the proximity to leading universities and research institutes—to attract investors. As the next section will show, Greater Philadelphia's main strength, and the major driver of its life sciences cluster, lies in its world-class universities and the human capital they produce.

Methodology

Data on the seven individual measures were collected and weighted to produce a final composite score for risk capital and entrepreneurship. These weights are given in the following table. These weights were designed to produce a heavier emphasis on two component measures of venture capital that are relatively better indicators of a region's risk capital and entrepreneurial capacity.

Risk capital measures	**Weights**
Life sciences VC investment	30%
Life sciences VC investment growth	8%
Number of companies receiving VC investments	30%
Growth in life sciences companies receiving VC investments	8%
Academic degrees awarded in entrepreneurship	8%
Business starts in life sciences	8%
Tech Fast 500 companies in life sciences	8%

The current data on venture capital were collected from PricewaterhouseCoopers (PWC). The number of academic degrees awarded was obtained from the National Center for Education Statistics (NCES). The number of business starts in life sciences was compiled from Harris Infosource, and the Tech Fast 500 list of companies originated from Deloitte & Touche. A summary of data sources can be found at the end of this chapter.

Human Capital

Human capital is yet another essential component of a region's innovation pipeline. Its importance has been acknowledged by many contemporary scholars. Human capital can be leveraged to promote economic development.[7] Companies base themselves in high-value-added industry clusters in order to draw on pools of talents in the region.[8] Because talented professionals have the ability to create and transmit knowledge, human capital is integral to innovation. Educational and training programs are thus developed to nurture the necessary human capital for today's economy, which is increasingly reliant on innovation.[9]

While the industrial economy was driven by capital, production processes, and infrastructure, the knowledge-based economy is premised on innovation and ideas. These augment the importance of human capital in knowledge-driven industries such as the life sciences. The following table illustrates the individual measures used to operationalize human capital in this study.

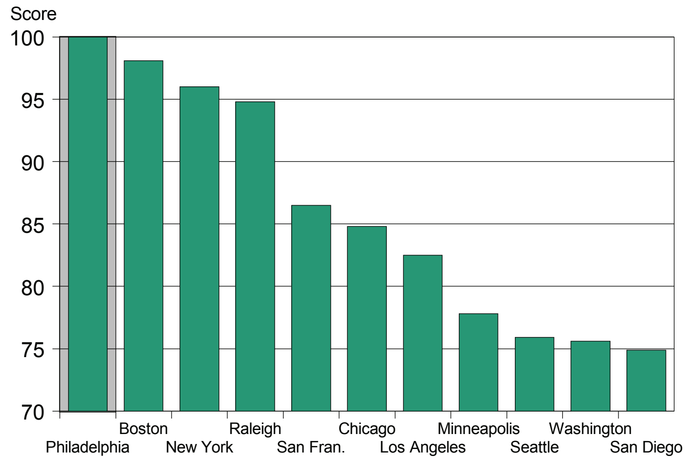
Human capital measures	**Definitions**
Life sciences bachelor's degrees awarded Life sciences master's degrees awarded Life sciences Ph.D.s awarded Medical doctor (M.D.) degrees awarded	These refer to the number of degrees in life science–related fields that were awarded in 2006 at different levels, including medical degrees.
Life sciences graduate students Life sciences postdocs	The numbers of postdoctoral graduate students in life sciences reflect the university-based research activities that take place in a region.
Ph.D.-granting institutions	The number of universities granting doctorate degrees in life science disciplines
Recent years' bachelor's degrees awarded in life sciences Recent years' master's degrees awarded in life sciences Recent years' Ph.D. degrees awarded in life sciences Recent years' medical doctor (M.D.) degrees awarded	These measures are similar to the corresponding measures above. However, they are measured on an extended basis (from 2002 to 2006) to reflect the accumulation of human capital assets.

An overall component for human capital was computed as a composite of all these measures. The findings show that Greater Philadelphia led the pack, with Boston and New York close behind in 2nd and 3rd, respectively. Compared to the findings in 2005, Greater Philadelphia has moved up two notches from 3rd place. This is illustrated

7. Ross DeVol, *State Technology and Science Index: Comparing and Contrasting California* (Milken Institute, 2002).
8. Ross DeVol, *California's Position in Technology and Science* (Milken Institute, 2004).
9. Bejamin Yeo, *Developing a Sustainable Knowledge Economy* (Germany: VDM Publishing, 2009).

in the following graph. These three metros, along with Greater Raleigh-Durham, outperformed the other metros by scoring more than 90 points in this measure.

Life sciences human capital
Selected metropolitan regions, 2009



Source: Milken Institute.

Greater Philadelphia has a long history of academic excellence and research. The region boasts one of the nation's largest and most distinguished clusters of academic institutions; together they support sophisticated research collaborations that form the base for a vibrant life sciences industry.[10] The region's key research-based universities—including the University of Pennsylvania, Temple University, and Princeton University—represent important cluster nodes in regional life sciences research. These, along with other human capital assets such as public and private research institutes have propelled the region a preeminent position in life sciences human capital.

Profile: The University of Pennsylvania

The University of Pennsylvania is home to the nation's first medical school, founded in 1765. It maintains a top-flight reputation to this day, having recently been named number four in the United States for research in the 2008 survey of medical schools. Emphasizing interdisciplinary collaboration, the School of Medicine hosts eighteen centers and institutes, including the Abramson Cancer Center; the Penn Cardiovascular Institute; the Institute for Diabetes, Obesity, and Metabolism; and the Penn Comprehensive Neuroscience Center.[11] Research from the school has led to several recent medical discoveries, such as a valve for patients with emphysema. Penn researchers also issued the first comprehensive study showing that magnetic resonance imaging (MRI) is a more accurate tool for detecting breast cancer than traditional mammography.[12]

10. Mike May, "A Rich Life Science Cluster," The Scientist, January 2008, http://www.the-scientist.com/2008/01/01/s10/1/.
11. University of Pennsylvania School of Medicine, Research Overview & Strategic Focus, http://www.med.upenn.edu/research_overview.shtml.
12. "Umbrella-like Valve May Help Patients with Emphysema Breathe Easier," October 23, 2006 (accessed at http://www.news-medical.net/?id=20728; study presented at the 2006 annual meeting of the American College of Chest Physicians), and "Magnetic Resonance Imaging Better Than Traditional Mammography for Detecting the Presence of Breast Cancer," June 10, 2004 (accessed at http://www.news-medical.net/?id=2341).

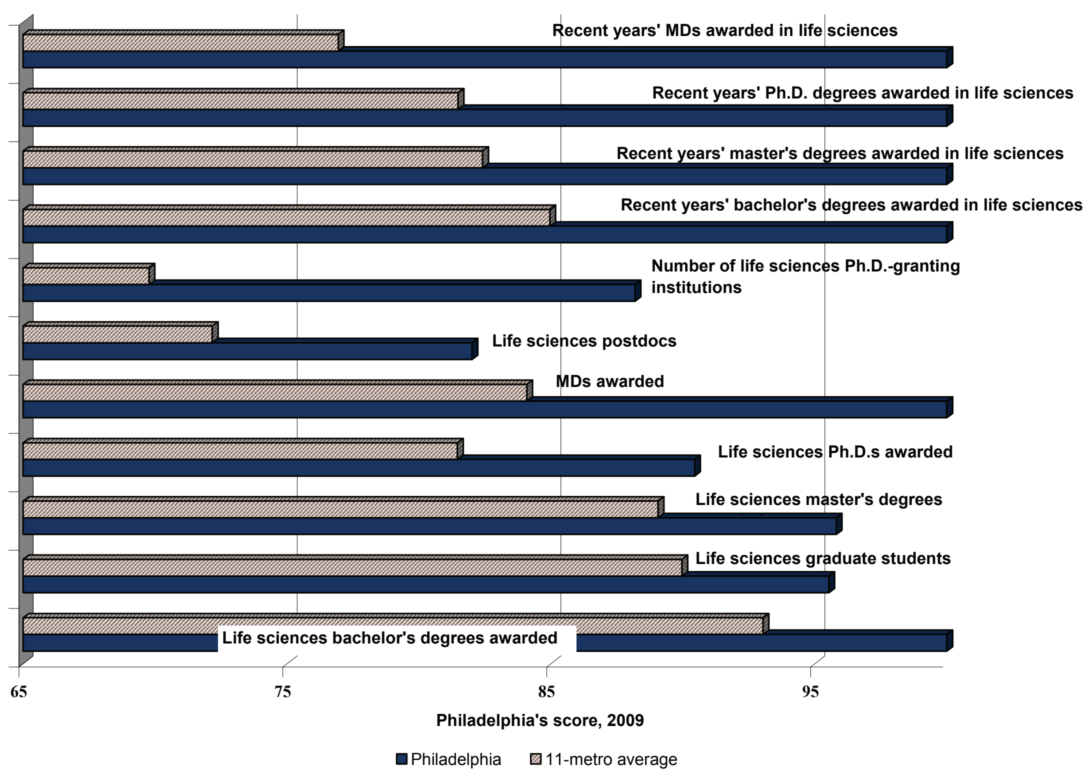
Temple University is another of the region's notable research-based universities with a strong focus on life sciences disciplines. It is home to seven major interdisciplinary research programs, plus an Office of Clinical Trials that coordinates with industry partners to further research.[13]

Profile: Temple University

Temple University also plays an important role in Greater Philadelphia's life sciences cluster. With strong medical curricula, Temple has produced discoveries in laryngology, preventive medicine, immunology, chemotherapy, neuroscience, and cardiology, among other fields.[14] Some of its recent breakthroughs include effective treatments for childhood anxiety disorders and the finding that a single tumor-suppressor gene may lead to unique marking for senescence in mesenchymal stem cells (MSCs) in vitro.[15]

The following graph illustrates Greater Philadelphia's performance in each of the eleven measures that make up the human capital composite. The solid dark bars represent Greater Philadelphia's score in each category, while the shaded ones depict the corresponding eleven-metro averages.

Greater Philadelphia's life sciences human capital scores
2009



13. http://www.temple.edu/medicine/research/index.htm.
14. Ross DeVol et al, *The Greater Philadelphia Life Sciences Cluster* (Milken Institute, 2005).
15. "Three Effective Treatments for Childhood Anxiety Disorders Found," News-Medical.net (accessed at http://www.news-medical.net/?id=42271), and "Gene Marker May Improve Odds of Stem Cell Therapies for Disease" (accessed at http://www.news-medical.net/?id=44785).

As shown in the graph on the preceding page, Greater Philadelphia performed better than the eleven-metro average in all measures. In fact, it was the top-scoring region in six of the eleven individual measures: bachelor's degrees awarded in the life sciences; medical (M.D.) degrees awarded; and recent years' bachelor's, master's, doctoral, and medical degrees awarded in life sciences. By comparison, in the 2005 study, Greater Philadelphia didn't record a single 1st-place score, although several of its scores were in the top three. This depicts the stunning gains that the region has made in producing human capital. In these six measures, Greater Philadelphia's performance was also well above the eleven-metro average.

Overall, the findings suggest that Greater Philadelphia has entrenched strengths in human capital and has taken action to reinforce them. Since its performance in recent years was better than in the 2005 analysis, it can be inferred that the other metros are not maintaining the same pace of improvement. Greater Philadelphia maintained its top position in terms of medical degrees awarded, and top-three positions in the remaining measures. Effectively leveraging its human capital is the key to further enhancing Greater Philadelphia's innovation pipeline by boosting its performance in the other four components.

Profile: Princeton University

A member of the elite Ivy League (as is the University of Pennsylvania), Princeton is yet another world-class research-based university that nurtures the knowledge assets necessary to fuel the life sciences and the regional economy. The university has several Ph.D. programs in life science–related disciplines, such as molecular biology, chemistry, and chemical engineering.[16] It is also home to the Lewis-Sigler Institute for Integrative Genomics and the Princeton Neuroscience Institute, two major research arms. In 2009, Joshua Shaevitz, an assistant professor in the former institute, was awarded almost $1 million by the NSF to study bacteria. A year earlier, Coleen Murphy, an assistant professor at the Princeton Neuroscience Institute, received the NIH Director's New Innovator Award (worth $1.5 million) to study the underlying causes of aging.[17]

Methodology

Data on degrees awarded in the most currently available year were compiled for the eleven metros and rebased according to the respective region's population ages 25–34. Similar to the prior study, this cohort allows a good representation of the degrees awarded in each region for comparison. The same approach applies to data on the number of graduate students, postdoctorates, and Ph.D.-granting institutions in the life sciences. Data on the corresponding degrees awarded in recent years were rebased according to the number of civilian workers, again similar to our approach in the prior study. The overall scores and ranks were determined by raw and rebased scores.

The data were obtained from the National Science Foundation (NSF). The latest years available were 2002 to 2006. Comparable data were used to rebase the individual raw data for each region for analysis. A summary of data sources can be found at the end of this chapter.

16. Princeton University, Academic Departments and Programs 2009, http://www.princeton.edu/main/academics/departments.
17. Princeton Neuroscience, "Coleen Murphy Awarded 2008 NIH Director's New Innovator Award," http://neuroscience.princeton.edu/cgi-bin/neuro/site/news_info.pl?id=34

Life Sciences Workforce

A strong science and technology workforce is made up of a specialized group of workers who have unique skills tailored to particular fields in the industry. Assembling a specialized workforce is an essential step for an industry to expand and for firms to grow. Science and technology workers are critical in the creation of economic value in the innovation, product development, and mass manufacturing processes. These workers do not just access knowledge and apply it to firm-specific objectives; they actually harness new information to generate new knowledge, bringing both inductive and deductive analytical skills to complex problems, creating both new concepts and processes.[18]

In the case of the life sciences, workers specialize in biomedicine, chemistry, microbiology, and other fields. A life sciences workforce constitutes the extension from innovation to production in an innovation pipeline. While it is important to create knowledge, it is also critical to put created knowledge into production. This requires specific technical skills. Life sciences workforce is thus computed using thirteen measures that look at the occupational concentration of thirteen types of workers in a region. These are given in the following table.

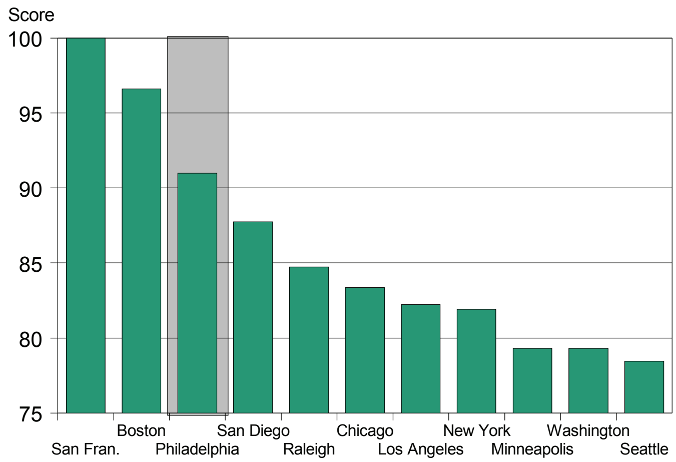
Workforce measures	Definitions
Intensity of medical and health services managers Intensity of biomedical engineers Intensity of chemical engineers Intensity of material engineers Intensity of electro-mechanical technicians Intensity of biochemists and biophysicists Intensity of microbiologists Intensity of medical scientists, except epidemiologists Intensity of chemists Intensity of materials scientists Intensity of biological technicians Intensity of chemical technicians Intensity of sales representatives, wholesale and manufacturing, technical and scientific products	We used intensity rather than absolute numbers in this component to reflect the extent of labor-clustering in a region. In this study, the intensity of an occupation refers to the number of a given life sciences occupation relative to the total number of workers in a region. The thirteen occupations listed in this measure are based on definitions determined by the Bureau of Labor Statistics (BLS). These occupational specializations are related to the life sciences industry. This mix of occupations reflects the characteristics of a life sciences cluster as it includes research, manufacturing, and service specializations.

18. Ross DeVol and Anita Charuworn with Soojung Kim, *California's Position in Technology, and Science* (Milken Institute, 2008).

With such an enviable human capital base, it is not surprising that Greater Philadelphia also has a strong life sciences workforce. Indeed, the metro area finished in 3rd place (after San Francisco and Boston) in this component. These metros are also the only three among the eleven metros to exceed 90 in rebased scores. The following graph illustrates these rankings.

Life sciences workforce

Selected metropolitan regions, 2009



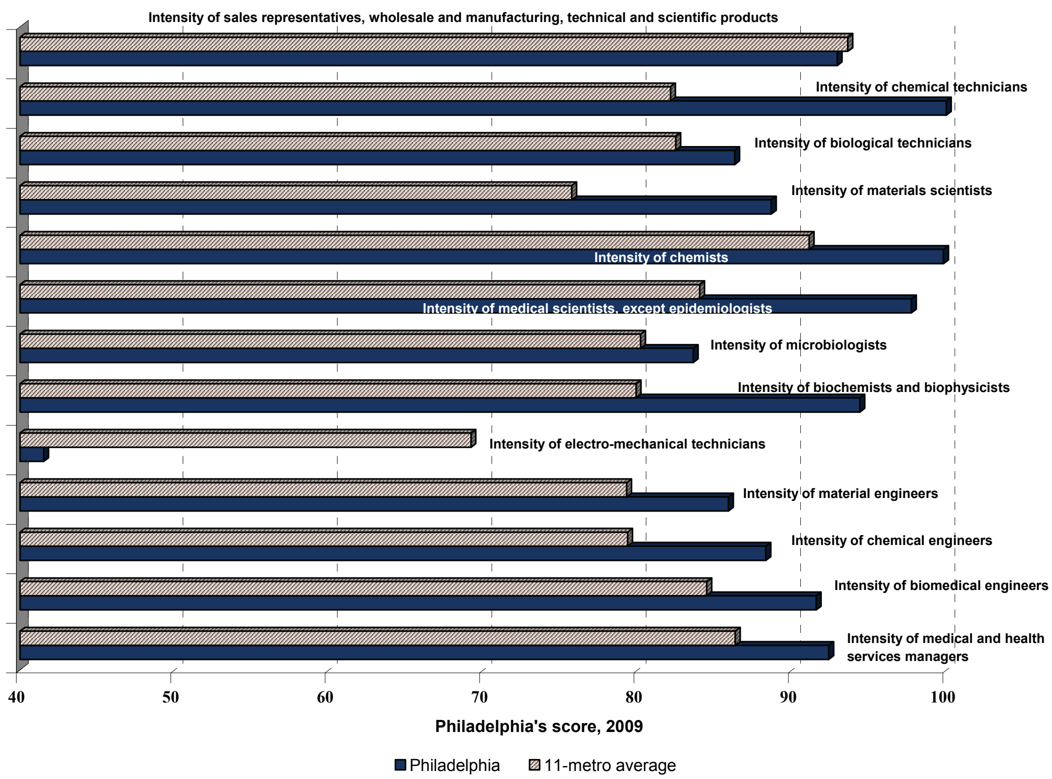
Source: Milken Institute.

Compared to the findings in our previous study in 2005, Greater Philadelphia moved up by two positions to overtake San Diego and Greater Raleigh-Durham, which occupy the 4th and 5th positions, respectively, in this current study. In 2005, Greater Philadelphia trailed those two metros by a small margin, but today it leads them by margins of three and six points. Also, in 2005, Greater Philadelphia's workforce performance was equal to that of Greater New York, a biopharmaceutical heavyweight. Based on current findings, Greater Philadelphia now outperforms New York by almost ten points.

The following graph illustrates Greater Philadelphia's performance in each of the thirteen individual measures of life sciences workforce in relation to the corresponding eleven-metro averages.

Greater Philadelphia's life sciences workforce scores

2009



In almost all life sciences occupations, Greater Philadelphia exceeded the eleven-metro average. It is important to note that the region's greatest workforce strength lies in chemistry. Based on the findings, Greater Philadelphia scored highest in chemistry-related professions, including chemical engineers (2nd), biochemists and biophysicists (2nd), chemists (2nd), and chemical technicians (1st). Particularly with chemists, Greater Philadelphia trailed 1st-place Raleigh by a margin of less than one point, a margin that stood at six points in 2005.

Several observations from our preceding 2005 study still hold true today. Greater Philadelphia could improve its overall position by enhancing its biological technical services (currently ranked 5th), biomedical engineering (currently ranked 3rd), materials engineering (currently ranked 3rd), electro-mechanical technical services (currently ranked 8th), and material science occupations (currently ranked 2nd).

The findings in the current study show that Greater Philadelphia has successfully boosted these occupations, except electro-mechanical technicians. In the other four occupations noted in the paragraph above, Greater Philadelphia outperformed the eleven-metro average. Of note, in biological technical services, Greater Philadelphia was ranked slightly behind San Diego in the 4th position, with a 0.6-point gap—a marked contrast to the five-point gap that existed between the two metros in 2005, when Greater Philadelphia and San Diego were in 7th and 4th places, respectively. San Diego maintained its strength in this measure, while Greater Philadelphia made strides that enhanced its relative position.

Greater Philadelphia must continue to shore up these occupations. Given its strong human capital assets, successful leveraging of its talents can allow the region to strengthen the intensities of these occupations. Establishing further university-industry partnerships can close the human capital–workforce gaps. Indeed, although Greater Philadelphia excels in human capital assets, there is room for further growth in its life sciences workforce. Attracting and retaining these key life sciences occupations is a natural outgrowth from its well-established human capital assets.

Methodology

In each of the thirteen component measures that make up this composite, the absolute number of life sciences workers for each region was rebased to its respective total workforce population (that is, per 100,000 workers, as shown in the Appendix). This measure of intensity by occupation enabled a fair and comprehensive assessment of the eleven metros. The final scores and ranks were based on computation of the raw and rebased values.

All data used in this component were compiled from the Bureau of Labor Statistics (BLS), using statistics from 2007, the latest year available for the same year for all component measures. A summary of data sources can be found at the end of this chapter.

Innovation Output

Drugs, devices, and medical innovation require rigorous testing before they can be commercialized. Similarly, ideas and inventions go through a process of research and development before they can be patented and commercialized. A region's innovation output is the ultimate result. This final component of the innovation pipeline is captured using eleven individual measures as shown in the table below.

Innovation output measures	**Definitions**
	These three phases are typical for clinical testing of drugs for FDA approval:
Clinical trials (Phase I)	*Phase I* trials seek to establish safe dosages and gather information on absorption, distribution, metabolic effects, excretion, and toxicity.
Clinical trials (Phase II)	*Phase II* clinical trials are designed to see whether the drug or treatment is effective and to further evaluate its safety. To provide evidence of a drug's therapeutic benefit, it is necessary to compare its effectiveness with that of standard, medically accepted treatments (which may include a placebo).[19]
Clinical trials (Phase III)	In *Phase III* trials, researchers firmly establish the drug or treatment's effectiveness, uncover side effects, compare it to commonly used treatments, and collect information that will allow it to be used safely.[20]
Clinical trials (Phase IV)	*Phase IV* trials refer to tests on a drug's risks, benefits, and optimal use.[21] These trials are conducted after Phase III when the drug is commercialized.
Patents issued Patents filed	The number of patents issued and filed by a university suggests its level of activities in producing innovation.
R&D expenditures	The funding expended on R&D by a university reflects its focus on commercializing inventions.
University startups	The number of startup companies launched by a university or based upon its intellectual property shows its ability to commercialize its inventions.
Licensing income received	The amount of income received through licenses by a university reflects the quality of its innovation.
Premarket approvals	Premarket approval is the scientific review process required by the FDA on all class III medical devices—the most heavily regulated category of devices—to ensure their safety and effectiveness.
Licenses/options executed	The number of licenses/options executed by a university suggests the actual quantity of inventions commercialized.

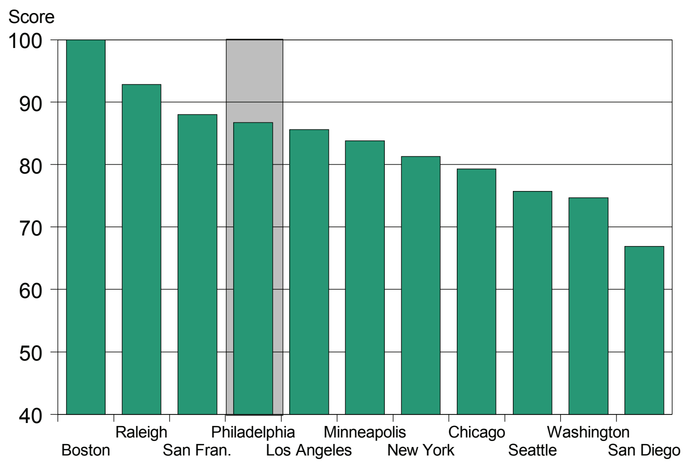
19. J. Lyle Bootman, Raymond J. Townsend, and William F. McGhan, "Introduction to Pharmacoeconomics," *Principles of Pharmacoeconomics, 2nd Edition* (Cincinnati: Harvey Whitney Books Company, 1996).
20. The three-phase clinical trials are defined by the Food and Drug Administration in the Code of Federal Regulations. Our descriptions are based largely on: Joseph A. DiMasi, Ronald W. Hansen, and Henry G. Grabowski, "The Price of Innovation: New Estimates of Drug Development Costs," *Journal of Health Economics,* 22 (2003):151-185, and National Library of Medicine, "Information on Clinical Trials and Human Research Studies" (2004; accessed at http://clinicaltrials.gov/ct/info/whatis).
21. U.S. National Institutes of Health, Glossary of Clinical Trials Terms, http://clinicaltrials.gov/ct2/info/glossary.

Boston has maintained top ranking it held in the 2005 study, while Greater Raleigh-Durham displaced Greater San Francisco in 2nd place. Greater Philadelphia, although trailing San Francisco by just one point, finished in 4th place, thus slipping one notch since 2005. The top two metros were the only finishers to reach the top percentile.

Greater Philadelphia's performances in life sciences innovation output and R&D capacity are highly correlated. Given the region's relative position, a few advances could push it above Greater San Francisco. The following graph illustrates these findings.

Life sciences innovation output

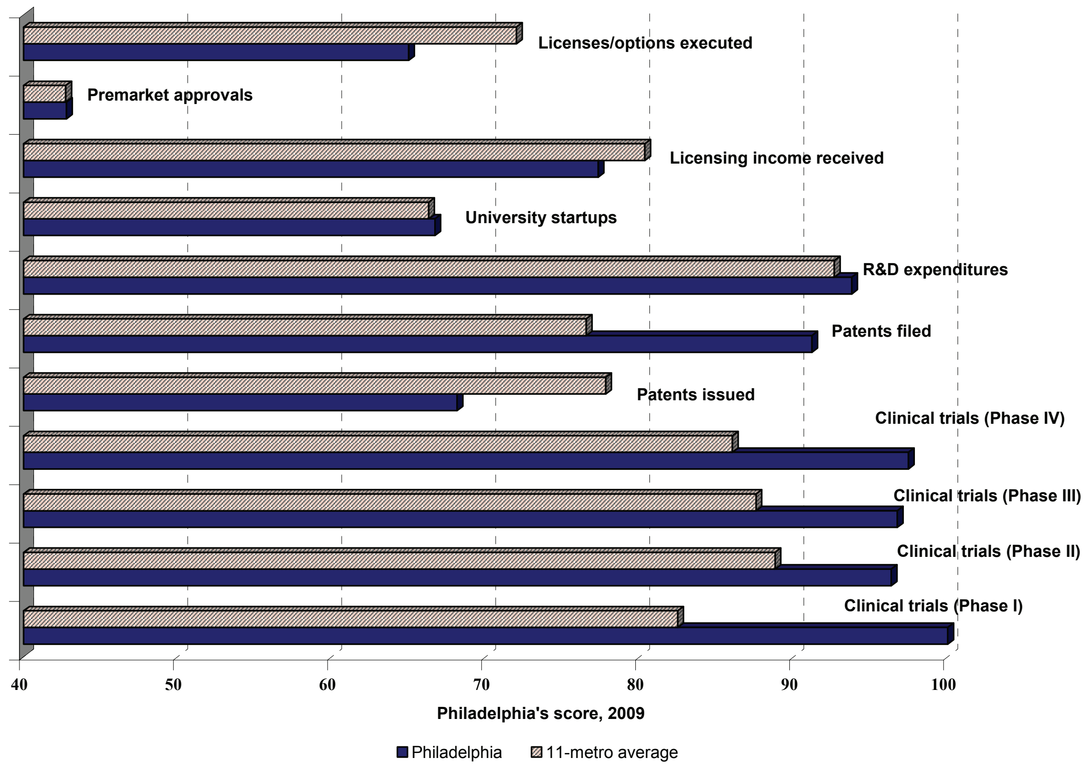
Selected metropolitan regions, 2009



Source: Milken Institute.

Greater Philadelphia's performance in each of the eleven measures of life sciences innovation output can be seen in the following graph. The bars represent Greater Philadelphia's score in each measure, along with the corresponding eleven-metro average scores.

Greater Philadelphia's life sciences innovation output score
2009



As shown, Greater Philadelphia excelled in the measures covering clinical trials and patents filed. In Phase I, II, and III clinical trials, the metro outperformed most of its peers, with 1st-, 2nd-, and 3rd-place finishes, respectively. In terms of Phase II and III trials, Greater Philadelphia trailed 1st-place Raleigh by three and four points, respectively.

We used Phase IV trials as a proxy for drug approvals. Based on the findings, Greater Philadelphia again outperformed the eleven-metro average to occupy 3rd place, after Great Raleigh-Durham and Boston. Importantly, Greater Philadelphia was only three points behind Raleigh and two behind Boston.

Greater Philadelphia has also been active in filing university patents. It is important to note that due to data limitations, these numbers refer to *all* patents that were filed and issued, and hence include other types of inventions along with life sciences patents. However, these numbers are still indicative of the innovation output activities in each region. In 2007, although Greater Philadelphia filed 593 patents, only eighty-eight were issued. In contrast, Boston, the top metro in this measure, filed a total of 996 patents and had 345 issued. It is therefore not surprising to find the number of licenses/options executed in Greater Philadelphia below the average among the eleven metros.[22]

22. Similar to patents, data on licenses/options, university startups, and licensing income include additional fields along with the life sciences, due to data limitations in the Association of University Technology Managers survey.

Greater Philadelphia boasts a legacy of leading universities that have strong life sciences specializations. The number of university startups and R&D expenditures in Greater Philadelphia are on par with the eleven-metro average. However, the region needs to further capitalize on these assets to boost its innovation output. Greater Philadelphia's competitive NSF funding rate was considerably lower than that of the metros on average. Its performance in R&D capacity was also weaker than in the other components.

Yet at the same time, Greater Philadelphia has strong human capital and workforce bases in the life sciences, supported by a wealth of risk capital. Since the previous study, the region has been actively enhancing these assets, particularly the workforce component. Further successful leverage will enable the region to appropriate maximum value from its science and technology legacy as well as the clustering effect to improve its performance in R&D and in turn boost its innovation output. These opportunities are evident, and the momentum is already building up as Greater Philadelphia has shown improvements in several measures since 2005.

Recent Breakthroughs

Greater Philadelphia has produced a number of new scientific discoveries and medical innovations in recent years.

Centocor, Inc., developed Remicade® to become the global market leader in tumor necrosis factor-alpha treatments.[23] This compound is also the first approved medicine for rheumatoid arthritis and Crohn's disease in North America, the European Union, and Japan. [24]

Through its UltiMab® technology, Medarex, Inc., seeks to develop a wide range of fully human antibody therapeutics in the treatment for life-threatening diseases such as cancer, inflammation, autoimmune disorders, and infectious diseases.[25] These set a standard for the market by being totally human, having a very high affinity, and able to produce quickly and efficiently.[26]

Wyeth Pharmaceuticals, a life science anchor firm in Greater Philadelphia, developed BeneFix®, the first medicine that uses recombinant technology to control and prevent hemophilia B.[27] The company received approval from the FDA in 2007. This medicine can be effectively used in smaller amounts than its predecessor, and does not require the use of needles.[28]

23. Select Greater Philadelphia, Life Sciences Success Stories, http://www.selectgreaterphiladelphia.com/look/ls_sstories.cfm.
24. Centocor, Inc., Remicade® (Infliximab) Fact Sheet, http://www.centocor.com/centocor/virtualpressoffice/remicade_factsheet.html
25. Select Greater Philadelphia.
26. http://www.medarex.com/Development/UltiMAbAdvantage.htm
27. Select Greater Philadelphia.
28. "Wyeth Receives FDA Approval for New BeneFIX Features That Provide Hemophilia B Patients a Simpler and More Convenient Preparation Process," Medical News Today, http://www.medicalnewstoday.com/articles/66164.php

Methodology

Similar to the preceding components, data on innovation output were collected and analyzed for all eleven metropolitan regions. Likewise, the measures were based on relevant proportioning, such as the number of life sciences workers in each region. The final rankings take into account both raw and proportioned elements for an even assessment. Similar to the 2005 study, the component measures in this section received weighting as follows in order to provide a true-to-life composite index.

Innovation output measures	Weights
Clinical trials (Phase I)	5%
Clinical trials (Phase II)	5%
Clinical trials (Phase III)	5%
Clinical trials (Phase IV)	20%
Patents issued	15%
Patents filed	5%
R&D expenditures	5%
University startups	5%
Licensing income received	5%
Premarket approvals	15%
Licenses/options executed	5%

Data compiled and analyzed for this component originated from the U.S. Food and Drug Administration (FDA), a division of the Department of Health and Human Services, and the Association of University Technology Managers (AUTM). All data interpretations and regional scoring and rankings involved independent models employed by the Milken Institute.

Data Sources

Life sciences research and development capacity	
Industrial R&D	National Science Foundation
Academic R&D	
National Science Foundation research funding	
Competitive NSF funding rate	
Number of Small Business Technology Transfer (STTR) awards	National Institutes of Health
Small Business Technology Transfer (STTR) award dollars	
Number of Small Business Innovation Research (SBIR) awards	
Small Business Innovation Research (SBIR) award dollars	
National Institutes of Health (NIH) funding	

Life sciences risk capital and entrepreneurial infrastructure	
Venture capital investment	PricewaterhouseCoopers
Venture capital investment growth	
Life sciences companies receiving VC investment	
Growth in life sciences companies receiving VC investment	
Academic degrees awarded in entrepreneurship	National Center for Education Statistics
Business starts in life sciences	Harris InfoSource
Tech Fast 500 companies in life sciences	Deloitte & Touche

Life sciences human capital	
Bachelor's degrees awarded	National Science Foundation
Graduate students	
Master's degrees awarded	
Ph.D.s awarded	
M.D.s awarded	
Postdoctoral positions	
Ph.D.-granting institutions	
Recent years' bachelor's degrees awarded	
Recent years' master's degrees awarded	
Recent years' Ph.D.s awarded	
Recent years' M.D.s awarded	

Life sciences workforce	
Intensity of medical and health services managers	Bureau of Labor Statistics
Intensity of biomedical engineers	
Intensity of chemical engineers	
Intensity of material engineers	
Intensity of electro-mechanical technicians	
Intensity of biochemists and biophysicists	
Intensity of microbiologists	
Intensity of medical scientists, except epidemiologists	
Intensity of chemists	
Intensity of material scientists	
Intensity of biological technicians	
Intensity of chemical technicians	
Intensity of sales reps, wholesale and mfg., technical and scientific product	

Life Sciences Innovation Output	
Clinical trials (Phase I)	U.S. Food and Drug Administration
Clinical trials (Phase II)	
Clinical trials (Phase III)	
Clinical trials (Phase IV)	
Medical devices premarket approvals	
Patents issued	Association of University Technology Managers
Patents filed	
R&D expenditures	
University startups	
Licensing income received	
Licenses/options executed	

Life Sciences Establishments Analysis

A region's available talent pool is a crucial factor that determines its ability to attract large corporations and small firms alike. Physical proximity to key universities and institutions allows corporations to leverage the relevant human capital and workforce needed for their business operations, thus sparking a virtuous chain of growth opportunities. In addition, small firms, including spinoffs and startups, also have opportunities to thrive in this environment. The following section examines the importance of both large and small firms to the region's life sciences cluster.

Greater Philadelphia is known for its strong life sciences cluster, which has been a major driver of economic growth in the region. It can be argued that this strength stems from its traditionally outstanding knowledge assets, including its human capital and workforce. Consequently, it is not surprising to see a large number of life sciences anchor firms based here, with a flow of venture capital continuously feeding the industry. The legacies and spillover effects of large pharmaceutical companies such as Merck, Wyeth, GlaxoSmithKline, AstraZeneca, Bristol-Myers Squibb, and Johnson & Johnson are a major magnet for scientists and venture capitalists. As a result, life sciences activities from various parts of the pipeline—from basic research to manufacturing—are abundant.[1]

Select Greater Philadelphia

To build further growth momentum, Select Greater Philadelphia was launched to provide business marketing services to various companies in the region. The organization focuses on multiple industries, but has achieved a series of successes in the life sciences.

Collaborating with state and local officials, as well as Keystone complex executives, Select Greater Philadelphia was able to attract Osstem Co. Ltd., a South Korean producer of dental implants, to the region. The company has since purchased 28 acres of land and will invest more than $70 million to build a new facility for manufacturing operation at Bucks County's Keystone Industrial Port Complex (KIPC). Osstem Co. Ltd. expects to generate 600 local jobs over a five-year period.[2]

Another key achievement was the launch of WuXi AppTec, which was born through an acquisition of Philadelphia's AppTec by Wuxi Pharmatech of China in 2008. AppTec's local facility will be expanded as a result, focusing on biologics.[3] The life sciences market presence in Philadelphia combined with WuXi's low-cost pharmaceutical R&D services can potentially create links and enhance related business activities among other companies in the region.

The presence of large life sciences companies serves the region in at least two major ways. First, anchor firms play an important role in growing and sustaining the local innovation pipeline. They enable a region to establish and maintain a sizable skilled workforce. As we discussed earlier in the Innovation Pipeline chapter, Greater Philadelphia has formidable strength in life sciences human capital and workforce. This stems not only from its world-class universities, but also from the presence of the large, high-profile firms that anchor the industry. Indeed, these leading universities and anchor firms enjoy a mutually beneficial relationship.

1. Mike May, "Greater Philadelphia's Big Pharmas," The Scientist, http://www.the-scientist.com/2008/01/01/s14/1/.
2. Select Greater Philadelphia, Life Sciences Success Stories 2007, http://www.selectgreaterphiladelphia.com/look/ls_sstories.cfm.
3. Ibid.

The life sciences are a particularly dynamic field. To successfully compete, firms in this industry need to continuously innovate—and to do so, they draw on the R&D capabilities and knowledge assets of the leading universities in close proximity. At the same time, these anchor firms present students, researchers, and faculty with opportunities to seek internships, job placements, and strategic advisory roles. In an economy premised on knowledge, there are often linkages among firms based on human capital and innovation.[4] These value-driven academia-industry links allow Greater Philadelphia to grow and maintain its human capital assets as well as attract and retain its skilled and specialized workforce. Large firms are, therefore, the foundation of Philadelphia's life sciences cluster.

Second, these large firms offer templates for success, stoking smaller firms to emulate them. Networks of interdependence are often found within regional industry clusters. "Social isomorphism" refers to a social process by which organizations adopt the practices of others when experiencing similar situations or environments.[5] Particularly in knowledge-driven economies, where there is a strong emphasis on innovation, isomorphism can occur as a social phenomenon whereby smaller firms imitate the growth patterns and strategies of larger ones.

On a smaller but no less important scale, large anchor corporations participate in community programs that target various social issues and enhance the region's quality of life. In a meta analysis of 52 studies that examined the relationship between corporate social responsibility (CSR) and corporate financial performance (CFP), Orlitzky, Schmidt, and Rynes showed that social and environmental responsibility have positive impacts on a corporation's financial performance.[6]

Therefore, it is not uncommon to find related community programs in regions with a large number of anchors. In the case of Greater Philadelphia, many life sciences anchors have programs in place that contribute to the social landscape, from patient surveys to environmental issues to community work. For example, patient feedback not only serves to improve health care for patients in the local community, but it also enables the company to develop better products and services. More importantly, CSR programs from anchor firms can serve as a beacon for smaller firms in a region.

Large companies have the resources and capabilities to carry out these programs on a sufficiently large scale to impart greater effect. Smaller firms, however, must overcome both funding and logistical challenges to launch community programs. Major firms often have specially established arms to initiate community outreach, while smaller companies may lack the manpower to make their efforts substantial.

However, social entrepreneurship and community outreach have received recognition in Greater Philadelphia. In 2000, researchers found that there were approximately twenty-seven community-based organizations per 10,000 residents in Philadelphia.[7] These organizations can establish collaborations among life sciences firms, both large and small, to develop and execute programs for local communities.

GoodCompany Ventures is an incubator comprising a team of social finance investors focused on entrepreneurs who develop innovative technologies to address social needs. Entrepreneurs seeking capital from GoodCompany

4. Ross DeVol, et al. *America's Biotech and Life Science Clusters: San Diego's Position and Economic Contributions* (Milken Institute, 2004).
5. A. Hawley, "Human Ecology," *D. Sills International Encyclopedia of the Social Sciences* (New York: MacMillan, 1968), pp. 328-337.
6. Marc Orlitzky, Frank L. Schmidt, and Sara L. Rynes, "Corporate Social and Financial Performance: A Meta-Analysis," *Organization Studies* 24, no. 3 (2003).
7. E.C. Twonbly, et al., "Mapping Nonprofits in Philadelphia, Pennsylvania," Center for Nonprofits and Philanthrophy (The Urban Institute, 2000).

Ventures must demonstrate a mix of financial returns and social contributions. Launching in June 2009, this program was jointly developed by Resources for Human Development, Inc. (RHD).[8]

Resources for Human Development is a nonprofit organization headquartered in Philadelphia. Established in 1970, it provides social services and programs to diverse population segments in various states. Its varied programs include those related to mental health, developmental disabilities, education, children's services, as well as health centers and primary health care.[9] The presence of Resources for Human Development can facilitate the growth of social entrepreneurship in Philadelphia. Life sciences companies can leverage its resources to develop community outreach programs and provide more effective utilization of their products and services.

Cradles to Crayons

Cradles to Crayons is a community outreach organization that supports the distribution of used clothing to families in need. Founded in Boston, Cradles to Crayons is unique because it accumulates and tailors its distribution to the specific needs of families through service centers such as Project Home. It began operations in Philadelphia and seeks collaboration with large companies in the region, including large life sciences firms, to organize its community programs. One of its programs, called "Big Give," was a two-day event that also involved the participation of the Children's Hospital of Philadelphia, the People's Emergency Center and the School District of Philadelphia.[10] Cradles to Crayons seeks to continue developing collaborative programs to reach out to children living in poverty in Greater Philadelphia.

As a whole, Greater Philadelphia is poised to create more structured executions of community programs. The life sciences firms that are main drivers of the economy have been utilizing their resources and taking the lead in reaching out to nonprofits and public-charity organizations in support of their community efforts. A further step to leverage the embedded culture of community in Greater Philadelphia could be to extend these collaborations to small firms. Tighter integration into the Greater Philadelphia community makes firms less susceptible to recruitment efforts by other regions.

Small Firms Benefit the Greater Philadelphia Economy

Small firms, especially those that engage in R&D, are the economic lifeblood of a community. This is a particularly critical element in the Greater Philadelphia area, given its dependence on the cutting-edge research and innovations of the life sciences industry. The presence of large life sciences firms provides fertile ground for spillovers of technology and science know-how, spawning new, smaller companies. By the same token, these agile firms help build an eco-system that allows larger firms to draw resources and gain flexibility in research and production.[11]

8. "GoodCompany Ventures Now Accepting Applications for 2009 Program," Corporate Social Responsibility News (http://www.csrwire.com/News/15003.html).

9. Resources for Human Development, Inc., "Program Areas," http://www.rhd.org/programs/prg_areas.asp.

10. Reuters. 2008. "Families and Organizations Invited to Give BIG for Children in Need," http://www.reuters.com/article/pressRelease/idUS174369+02-Sep-2008+BW20080902.

11. Ross DeVol et al., *America's Biotech and Life Science Clusters: San Diego's Position and Economic Contributions* (Milken Institute, 2004).

Small firms often embody entrepreneurial values and ideas. The underlying importance of entrepreneurship can be illustrated by the value placed upon it by governments in different regions around the world. Entrepreneurs represent innovation, triggering heightened competition and higher expectations in a market.[12] San Diego, for example, built on an agglomeration of universities and research centers; it made sound business sense for many small firms to locate near these institutions and near each other, thus allowing them to leverage common resources and lower costs.[13] These smaller firms can form linkages and create a value chain of production, thus lowering the burden of multidisciplinary resources required at the initial stages of R&D.

Leveraging Local Resources

Greater Philadelphia's knowledge assets, including its proximity to top research universities, leading life sciences companies, and support initiatives, can provide the building blocks for small companies.

Integral Molecular, a company that engages in biomedical research and drug development, is a prime example of this concept in action. The firm facilitates the development of drugs for integral membrane proteins that are involved in major diseases. Starting out with an initial budget of $100,000 in 2001, Benjamin Doranz started the company's operations at the Science Center in Philadelphia. The location and support from the center enabled Integral Molecular to collaborate with nearby universities such as the University of Pennsylvania and Drexel University, while also tapping into this rich talent pool to build the company's workforce. Integral Molecular is still growing and can draw on the region's knowledge assets for expansion.[14]

Small firms can also play an increasingly important role in attracting and retaining talented workers in a given region. As large pharmaceutical firms face the economic realities and pressures of global competition, they have to move into new markets and seek ever greater efficiencies, a process that often leads to the outsourcing of certain kinds of occupations. As this trend continues, small and expanding firms will be a crucial source of employment for the workers in transition.

For Greater Philadelphia, the employers of the future are likely to be the current small entrepreneurial firms with the next big idea. As large firms in Greater Philadelphia downsize and outsource to remain competitive, the high-skilled workforce of scientists, researchers, and administrators will seek alternative opportunities—and in many cases, they will look to the small firms that are the vanguard of the life sciences sector.

12. Benjamin Yeo, *Developing a Sustainable Knowledge Economy. The Influence of Contextual Factors* (Germany: VDM Verlag, 2009).
13. Ross DeVol, *America's Biotech and Life Science Clusters. San Diego's Position and Economic Contributions*.
14. "Avid Radiopharmaceuticals – Vision into Debilitating Neuro Disease," Science Center, http://www.sciencecenter.org/resident-companies/success-stories.

Regional Collaboration in Action

Genetic manipulation of plants has shown great promise as a safe, fast, and effective new strategy for producing antigens. The Fraunhofer USA Center for Molecular Biotechnology (CMB), a research center located in the Delaware Technology Park in Newark, Delaware, developed a genetic manipulation method to use tobacco plants as chlorophyll-fueled factories to produce vaccine antigens, therapeutic proteins, and other vaccine-related products.

The CMB was established in 2001 as a partnership between Frauhofer and the state of Delaware. It also boasts regional links to the Delaware Biotechnology Institute at the University of Delaware, where the center taps various resources such as nuclear magnetic resonance and DNA sequencing.[15]

The CMB has subsequently obtained funding from the Bill and Melinda Gates Foundation, the Defense Advanced Research Projects Agency (DARPA), and the Longwood Foundation (of Wilmington, Delaware) to support its vaccine projects. One noteworthy grant was obtained in 2006 from the Gates Foundation to develop vaccines against malaria.[16] Although it is still relatively small, the CMB is growing, thanks to the support it has received and the knowledge links it has established in the region.

Small firms are crucial to a region's economy, since they tend to be embedded into their local communities. They are usually locally owned, and often draw employees from smaller catchment areas and trade in a smaller radius than their larger corporate counterparts. Such firms are an integral part of the renewal process that pervades market economies. These new and small life sciences firms play a crucial role in experimentation and innovation that leads to technological change, productivity, and economic growth. These firms, with their new technologies, trigger the formation of networks with existing companies, researchers, and universities in the region to create a virtuous supply chain of innovation and commercialization. The growth of many small companies in the region serves as evidence of the region's new life sciences assets and continued momentum, further emphasizing their importance to Greater Philadelphia's life sciences cluster.

It is helpful to think of a regional economy as an ecosystem, requiring a broad diversity of companies to ensure its overall health. Thriving economies are constantly changing and evolving; the more diverse, the more easily they are able to adapt to natural transformations in social and market conditions. As the following section will show, Greater Philadelphia has a healthy and sustainable ecosystem that allows it to generate continuous growth. Supporting that contention is a recent report by PWC, showing that venture capital funds have continued to flow into Philadelphia's life sciences industry even in the face of the recession and global credit crunch.[17]

15. J. Perket, "Turning Tobacco into Therapies," http://www.the-scientist.com/2008/01/01/s68/1/.
16. "Fraunhofer CMB Receives Bill & Melinda Gates Foundation Grant to Develop Innovative Malaria Vaccines," BioSpace 2006, http://www.biospace.com/news_story.aspx?NewsEntityId=40385.
17. "Funding for Life Sciences on the Rise in Greater Philadelphia" (PricewaterhouseCoopers 2007 Q4 MoneyTree Report), Select Greater Philadelphia, http://www.selectgreaterphiladelphia.com/look/ls_funding.cfm.

Entrepreneurs tend to gravitate to communities with singular cultures—witness the numbers of high-tech workers who are drawn to Silicon Valley like a magnet. The Greater Philadelphia area exerts the same kind of pull in life sciences, consistently attracting new people, new employers, and new capital. The influx of talent and energy into the community brings economic vibrancy, creating a dynamic that cannot be replicated through any other means.

It is important to analyze the mix of life sciences establishments and how firms of different sizes impact the overall ecosystem in Greater Philadelphia. The changes in these establishments reflect the dynamism of its life sciences industry, thereby suggesting the degree of entrepreneurial activities. A strong life sciences cluster can be characterized as one with a high concentration of entrepreneurship. In the following section, we will analyze the trends for small life sciences establishments in Greater Philadelphia.

A Spin-off Success Story

The story of Avid Radiopharmaceuticals illustrates the process of how knowledge assets can give rise to new firms, innovations, and economic growth. Beginning in 1999 at the University of Pennsylvania, pathologist Daniel Skovronsky engaged in a project related to compound imaging. Fast-forward five years, and Skovronsky established Avid Radiopharmaceuticals at the Science Center in Philadelphia as a spin-off from the university. Today, Avid is a molecular imaging company that focuses on brain imaging. The company's pipeline of imaging compounds may be able to detect initial stages of pathological changes, thus enabling medical treatment before symptoms develop. This can potentially benefit patients with Alzheimer's disease, dementia, Parkinson's disease, and diabetes. Avid currently has a strong and diverse portfolio of investors made up of local incubators and large venture capital firms.[18]

18. Avid Radiopharmaceuticals – Vision into Debilitating Neuro Disease," Science Center, http://www.sciencecenter.org/resident-companies/success-stories.

A Start-Up Geared to Speed Up Genetic Analysis

BioNanomatrix is an early-stage company that specializes in molecular biology. The company is studying a nano-channel array microchip that will reduce the time needed to analyze long strands of DNA. The resultant application will reduce the treatment cost and time of genetic analyses.

The microchip is capable of storing the genetic information of 200 people. It came into fruition at Princeton University from a project funded by the Department of Defense. A member of the project team, Han Cao, originally a post-doctorate researcher the University of Pennsylvania, recognized the potential of the technology in human genome research. In 2003, he licensed the technology from Princeton and formed BioNanomatrix.

BioNanomatrix was subsequently supported by funding from Ben Franklin Technology Partners and the National Institutes of Health. The company set out on a joint venture in September 2007 with Complete Genomics Inc. (CGI). The partnership received $8.8 million in R&D funding from the U.S. National Institute of Standards and Technology / Advanced Technology Program (NIST-ATP) to advance the technology.[19]

Measuring the Presence of Small Firms

Similar to many other mature industry bases in the nation, Philadelphia's future lies in promoting entrepreneurial activities and creating new jobs. Particularly, the future growth of Greater Philadelphia's premier sector—the life sciences—will depend on the expansion and growth of smaller, nimbler, and more specialized firms. The ability of these firms to mature past the start-up stage and establish themselves in the industry is key.

Our analysis focuses on small firms with fewer than twenty employees. Many of these firms are crucial in creating employment opportunities and training that maintain a skilled local workforce, adding to the knowledge base of the region. Among them, we placed particular emphasis on firms in therapeutics and devices, since they typically evolve from an innovation. Examples of such firms include sole proprietorships and spin-offs from universities.

We used the National Establishments Time Series (NETS) database, which is maintained and managed by Walls & Associates.[20] It captures detailed firm-level data that track the behavior of firms annually. Importantly, the database includes firms of various sizes, such as those that have fewer than four employees. Many of these smaller enterprises are typically excluded from other major firm-level databases of a similar nature.

19. Avid Radiopharmaceuticals – Vision into Debilitating Neuro Disease," Science Center, http://www.sciencecenter.org/resident-companies/success-stories.

20. For more information on the NETS database, refer to http://www.youreconomy.org/nets/NETSDatabaseDescription.pdf.

The following table is a comparison of the shares of small firms in the life sciences sector among the eleven metro areas in our study. Compared to the ten other metros, Greater Philadelphia showed moderate strength in the vitality of its small life sciences firms. Despite its strengths in pharmaceuticals, small regional firms focused on therapeutics and devices showed only modest growth of 21 percent between 2002 and 2007. Moreover, for the same period, the region saw a decline of 13 percent in the number of small firms offering health-care services. It can be argued that the share measure is somewhat biased due to the heavier presence of larger companies in the Greater Philadelphia area. However, there is a tangible gap in performance relative to Greater New York and Greater Los Angeles in fostering small life sciences firms.

Life sciences small business vitality

Size and performance, 2007

	Therapeutics and devices			Health-care services			Life science support industries		
MSA	Absolute size	Share of all est.	Growth '02-'07	Absolute size	Share of all est.	Growth '02-'07	Absolute size	Share of all est.	Growth '02-'07
Boston	1,807	1.1%	42.1%	14,851	8.7%	3.7%	34	0.02%	13.3%
Chicago	1,682	0.6%	27.4%	21,914	7.6%	11.5%	69	0.02%	-10.4%
Greater Los Angeles	4,221	0.7%	37.9%	48,578	7.8%	6.5%	107	0.02%	-11.6%
Greater New York	3,089	0.4%	23.9%	50,122	7.2%	0.2%	93	0.01%	-21.8%
Greater Philadelphia	1,592	0.7%	20.9%	19,781	9.2%	-12.7%	56	0.03%	7.7%
Greater Raleigh-Durham	584	1.1%	52.5%	3,673	6.7%	23.5%	11	0.02%	22.2%
Greater San Francisco	2,667	1.0%	40.1%	20,572	8.0%	4.5%	41	0.02%	-10.9%
Minneapolis	846	0.7%	30.2%	6,963	6.1%	-11.3%	23	0.02%	-36.1%
San Diego	1,369	1.2%	38.3%	9,919	8.7%	16.3%	35	0.03%	-12.5%
Seattle	1,006	0.7%	17.1%	9,682	7.0%	-5.7%	30	0.02%	15.4%
Washington, D.C.	2,059	1.0%	39.9%	18,029	8.6%	-1.2%	27	0.01%	-12.9%

Sources : National Establishment Time-Series (NETS) Database, Walls & Associates, Bureau of Labor Statistics, Milken Institute.

We used the information compiled from the NETS data to compute a composite index measuring small business vitality in the life sciences. Based on the results, Philadelphia ranked 9th overall in terms of number, share and growth of small life sciences firms, as shown in the following table. Metropolitan regions in California (Greater Los Angeles, Greater San Francisco, and San Diego) demonstrated high vitality in this index, with Boston close behind in 4th place.

Life Sciences Small Business Vitality Index
Ranked by composite score

Rank	MSA	Therapeutics and devices	Health-care services	Life science supporting	Small Business Vitality Index
1	Greater Los Angeles	100	100	95	100.0
2	Greater San Francisco	98	74	68	91.1
3	San Diego	90	81	79	87.4
4	Boston	92	69	85	87.4
5	Greater Raleigh-Durham	88	71	85	85.0
6	Washington, D.C.	90	63	42	80.5
7	Greater New York	68	87	68	72.2
8	Chicago	61	82	98	69.5
9	Greater Philadelphia	61	55	100	63.9
10	Seattle	51	46	91	54.5
11	Minneapolis	61	36	42	54.3

Sources: NETS Database, Walls & Associates, Bureau of Labor Statistics, Milken Institute.

This finding from firm-level analysis is consistent with 2008 information on business starts in the life sciences, as discussed earlier in the Innovation Pipeline chapter. Greater Philadelphia occupied the 8th position in that component measure, while Greater New York was ranked 1st. This is also fairly consistent with Greater Philadelphia's 7th position in life sciences companies receiving venture capital investments in 2008. Taken together, life sciences entrepreneurship in Greater Philadelphia, as reflected by small firm establishment formation, has further room for growth.

The following table elaborates on these results. Over a period of ten years, Greater Philadelphia has experienced a relatively low birth rate of small life sciences firms. In addition, between 2002 and 2007, the death rate of small life sciences firms was the highest among the eleven metros we studied.

Birth rates of small firms in life sciences
Per 1,000 life sciences establishments

Rank	MSA	1997-2002	2002-2007	1997-2007
1	Greater Raleigh-Durham	403.7	264.5	775.0
2	San Diego	191.2	178.5	403.8
3	Minneapolis	490.8	-82.4	367.9
4	Greater Los Angeles	257.8	79.2	357.4
5	Washington, D.C.	282.1	14.1	300.1
6	Seattle	326.1	-43.7	268.1
7	Boston	156.9	62.3	228.9
8	Greater San Francisco	133.6	69.2	212.0
9	Greater New York	193.9	9.0	204.6
10	Greater Philadelphia	336.5	-109.3	190.5
11	Chicago	33.4	117.5	156.2
	11-metro average	255.1	50.8	315.0

Sources: National Establishments Time Series database, Milken Institute.

In part, the performance of Greater Philadelphia in small life sciences firms can be explained by the high change in corporate affiliation among these firms. The change in Headquarters (HQ) Duns number reflects a change in the corporate ownership in a firm. Using this measure as a proxy, we ranked the eleven metros to show the percentages of small life sciences firms that have experienced a change in corporate affiliation between 1990 and 2007. The following table shows the results.

Change in corporate ownership, 1990–2007

Rank	MSA	Change in HQ Duns number
1	Minneapolis	3.3%
2	Greater Philadelphia	3.3%
3	Greater Raleigh-Durham	3.1%
4	Chicago	2.8%
5	Washington, D.C.	2.6%
6	Seattle	2.5%
7	Boston	2.4%
8	Greater San Francisco	2.2%
9	San Diego	1.9%
10	Greater New York	1.8%
11	Greater Los Angeles	1.7%

Sources: National Establishments Time Series database, Milken Institute.

Although the percentages are generally small, Greater Philadelphia has one of the highest relative proportions of small life sciences firms that have experienced a change in corporate affiliation and a high rate of merger and acquisition (M&A) activity in the period. This suggests a high degree of movement and flexibility in Greater Philadelphia's life sciences.

The evidence supporting the M&A activities for firms in this size class is difficult to obtain. However, the larger companies in the region have engaged in frequent and fruitful acquisitions in life sciences space in the last decade. These activities often represent corporate strategic mergers and acquisitions for market positioning, while others involve the acquisition of target firms that the larger acquiring company actually sponsored during the earlier stages of research and development.

Compared to California and New York, private life sciences firms in Pennsylvania have triggered far greater numbers of acquisitions from outside the state between 2002 and 2007. As the following table notes, Pennsylvania has had forty-two acquisitions from parties outside the state, compared to only nine from within. California, on the other hand, had 175 and 110 of these transactions, respectively, for the same period. The same applies to New York, with thirty acquisitions from outside the state and twenty-one within. Massachusetts, although much smaller in size, had sixty-nine outside- and twenty-three inside-the-state acquisitions during the same period. Pennsylvania's neighbors, Delaware and New Jersey, showed results similar to Pennsylvania in this regard. Both states had a much larger number of foreign (i.e., outside state) acquisitions than local ones. Regions in these two states also constitute the Greater Philadelphia area.

Acquisition of life sciences firms
Selected states, 2002–2007

	Outside state	Within state
California	175	110
Delaware	5	0
Massachussets	69	23
New Jersey	47	7
New York	30	21
Pennsylvania	42	9

Source: Deallogic.

It can be inferred that Greater Philadelphia's life sciences firms are attractive to large companies outside the state. This could possibly explain the high death rate of small life sciences firms in the region between 2002 and 2007. Greater Philadelphia must leverage its established assets to support the growth of small life sciences firms that continue to trigger innovation, and thus, foreign attention. This would ensure the continuous birth of small, innovative life sciences ventures. At the same time, Greater Philadelphia can continue to steer capital investments into the region by focusing not only on firms up for acquisition, but also enhancing the strong innovation pipeline that is in place for higher risk capital and stronger technology commercialization.

Strategies for Supporting Growth

Greater Philadelphia is already known as a powerhouse in the life sciences. But the region can position itself for further growth by maintaining its appeal to investors. Besides enhancing infrastructure such as technology parks and conference venues, financial incentives are also in place to promote the region's life sciences industry. New Jersey, part of which is in the Greater Philadelphia region, created a tax certificate program in 1999 for biotechnology companies. Under this program, businesses are able sell tax losses or R&D tax credits to finance their growth and operations. As of 2007, the total funding allocated to this program stood at $445 million.[21]

Another New Jersey initiative, the Edison Innovation Fund was developed to cultivate life sciences and technology entrepreneurship in the region. In December 2006, the first $45 million of this fund was allocated to companies in the life sciences industry. For example, Provid Pharmaceuticals Inc. in North Brunswick received $750,000 to support its R&D activities, while Signum Biosciences in South Brunswick was awarded $1 million to finance testing procedures and R&D.[22]

Greater Philadelphia's small-firm industry landscape has the potential to grow. It has long-established knowledge assets in the life sciences and flexibility that can be more fully leveraged. The various life sciences represent an extraordinarily interdisciplinary field that touches on sub-disciplines in physics (such as nanotechnology) and computing (such as information systems). Many disciplines have been generated through collaborations among researchers from different areas. A good example is health informatics, which combines the medical and computing fields. By their very nature, life sciences companies often tread across industries.

21. Karen Asp, "A Region Poised for More Growth," The Scientist, http://www.the-scientist.com/2008/01/01/s84/1/.
22. Ibid

This characteristic of industry flexibility has been argued to be a facilitator of industrial growth. Although California's Silicon Valley and Boston's Route 128 have similar agricultural backgrounds, the centralized and independent industry structure in the latter led to its weaker industry performance compared to its counterpart in the West.[23] Similar to the computing industry, the dynamic and fast-changing interdisciplinary nature of life sciences also forces workers to adapt their skills to new market conditions. This form of labor flexibility is also a key factor that led to Silicon Valley's leadership in the information technology industry.[24]

Greater Philadelphia's legacy of knowledge assets places the region at an advantage in providing educational and training opportunities. Indeed, these assets and opportunities are what enable the region to grow and maintain a vibrant life sciences cluster. Compared to the other ten metros, Greater Philadelphia does not claim a relatively large share of small life sciences firms; nor does it show the most growth. But its life sciences industry has remained comparatively stable over a long period of time during which the entire industry has gone through significant evolution and restructuring. In the Current Impact analysis chapter, we noted that Greater Philadelphia outperformed the other ten metros. Its pharmaceutical industry remains its vital foundational strength. The presence of establishments in therapeutics and devices as a whole was fairly average (in terms of therapeutics and devices establishments per 10,000 total business establishments, the region was ranked 6th among the eleven metros). Yet when combined with employment measures, the current impact of the sector in the region propelled it past all the other metros.

These findings suggest that the stability and strength of Greater Philadelphia's life sciences industry hinges upon its large companies. These anchors have continued to expand beyond the measurement of payroll and led to the region's improved current impact since our last assessment in 2005.

To preserve its legacy and enhance its future performance, Greater Philadelphia can initiate incubating programs tailored to the needs of local life sciences entrepreneurs by creating opportunities to collaborate with the large anchors. In addition, public policies can also play important roles in facilitating industry development, such as the creation of new employment opportunities and directing foreign investments. However, local contexts can affect the impact of these programs and policies.[25]

Every region has its own characteristics and challenges. We have shown that Greater Philadelphia stands out from the other metros, particularly with its longstanding knowledge assets and its flexible industry characteristics. The programs and policies initiated in Greater Philadelphia must take into consideration its unique local characteristics.[26] In highly knowledge-based industries, this approach will lead to higher productivity.[27] Wisely targeted initiatives can give small segments of creativity better chances to surface and establish links with large companies, universities, and venture capital.

23. Anna Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge: Harvard University Press, 1996).
24. Chris Benner, *Work in the New Economy. Flexible Labor Markets in Silicon Valley* (Wiley-Blackwell, 2002).
25. Benjamin Yeo, *Developing a Sustainable Knowledge Economy: An Investigation of ContextualFactors* (Germany: VDM Verlag, 2009).
26. John Houghton and Peter Sheehan, "A Primer on the Knowledge Economy," Centre for Strategic Economic Studies, Victoria University (Australia), 2000 (available at www.cfses.com/documents/knowledgeeconprimer.pdf.)
27. Maryann Feldman, "The Importance of Proximity and Location: Knowledge and Place: Proximity," U.S. National Science Foundation, 2005.

Greater Philadelphia can maximize future growth by better deploying its existing resources to create collaborations among large and small firms to generate products and services for the market. Life-science support organizations, trade groups, early-stage investors, and economic development groups must work to nurture greater interaction among large and small firms. A culture of collaboration will create a dynamic and renewable supply chain of innovation and production. In the process, the region can trigger growth in life sciences entrepreneurship and, in turn, generate long-term sustainable growth.

Overall Composite Index

Our Overall Composite Index for Life Sciences provides a single comprehensive measure of how Greater Philadelphia is positioned relative to other elite clusters in the United States. To arrive at these results, we utilized the Current Impact, Innovation Pipeline, and Small Business Vitality indexes detailed in the preceding chapters. Combining the results produces a powerful assessment tool for analyzing how various life science clusters compare.

The Current Impact Index measures where Greater Philadelphia stands in the current continuum of top clusters by examining employment and establishments in terms of absolute and relative size, diversity, and recent growth performance. The Innovation Pipeline captures each cluster's ability to innovate, commercialize research, and sustain its long-term competitiveness. Small Business Vitality evaluates how successful regions are in creating new entrepreneurial firms, which are the lifeblood of cluster sustainability.

Greater Philadelphia moves up to 2nd place in the Overall Composite Index with a score of 97.7, moving up from its 3rd-place finish in our 2005 analysis. It achieved this improvement, in part, by increasing the margin of its 1st-place advantage in the Current Impact Index to 7.0 index points, greatly expanding the narrow 0.3 lead it posted in 2005. Greater Philadelphia maintained its dominant position in pharmaceuticals, but its strengthened position in the Current Impact Index can be attributed to advances in biotechnology R&D and continued top-tier performance in health-care services and life science–supporting industries. Improved access to pre-seed, seed, and early-stage risk capital is helping to elevate its status in biotechnology.

Overall Composite Index for Life Sciences

Rank	Metro area	Current Impact	Innovation Pipeline	Small Business Vitality	Overall Composite Index score
1	Boston	91.3	100.0	87.4	100.0
2	Greater Philadelphia	100.0	91.7	63.9	97.7
3	Greater San Francisco	80.7	93.2	91.1	92.1
4	Greater New York	92.7	85.2	72.2	92.0
5	Greater Raleigh-Durham	79.7	87.4	85.0	88.2
6	Greater Los Angeles	79.0	81.7	100.0	86.8
7	Chicago	76.4	77.0	69.5	80.1
8	San Diego	66.9	79.5	87.4	78.7
9	Minneapolis	72.2	80.5	54.3	78.2
10	Washington, D.C.	63.3	76.3	80.5	74.8
11	Seattle	53.5	80.2	54.5	69.2
	Weights	0.45	0.45	0.10	

Despite remaining in 3rd place in the Innovation Pipeline Index, Greater Philadelphia largely closed the gap with 2nd-place Greater San Francisco. Once 4.4 points behind in our 2005 study, Greater Philadelphia is now only 1.5 point behind in this year's analysis. It posted its biggest improvement in the risk capital and entrepreneurial infrastructure component, jumping 13.3 index points from its 2005 score. Greater availability of risk capital, and the presence of entrepreneurs capable of deploying it, boosted the region's performance in biotechnology. And remarkably, Greater Philadelphia managed to jump into 1st place in human capital, supplanting the historical leader, Boston.

Greater Philadelphia's weakest performance came in Small Business Vitality. Among establishments with twenty or fewer employees, it came in at 9th place. The region has yet to develop the entrepreneurial sophistication of such clusters as Greater San Francisco, San Diego, Boston, Greater Los Angeles, or Greater Raleigh-Durham. Greater Philadelphia has been more successful, however, in growing small firms into medium-sized firms, a process that adds large chunks of employment. Small establishments in the life sciences do not represent a sizable portion of the employment base in Greater Philadelphia. Greater Los Angeles, by contrast, ranked 1st in Small Business Vitality, with an assortment of small firms and respectable growth.

Conclusion

Greater Philadelphia is a vibrant life science cluster with many advantages. Boston ranks 1st overall, but by a slimmer margin than it enjoyed in our 2005 study. Boston has higher concentrations of medical devices and biotechnology than Greater Philadelphia, which has its historical roots in the pharmaceutical industry. Boston's leading universities are scientific research stalwarts, and indeed, Boston increased its lead over Philadelphia in R&D in this year's analysis. Equally important, these institutions have a long history of active participation in Boston's commercialization ecosystem. The number of university-based startups in Greater Philadelphia is just above the eleven-metro average, indicating that its extensive strengths in research have yet to be fully captured in the region's economy.

Greater Philadelphia is closing the risk capital gap with Boston and Greater San Francisco, but it doesn't yet have an extensive network of collaborating agents in place. Greater Philadelphia has been able to offset this disadvantage with massive amounts of industry R&D in the life sciences, principally at its pharmaceutical firms.

There are challenges and opportunities for Greater Philadelphia. One of the issues confronting the region is that market forces are causing consolidation in the pharmaceutical industry, and many jobs will be eliminated in the process. On the other hand, if its rich human capital base can be quickly redeployed—by attracting biotech firms or starting more of its own and growing them to maturity—Greater Philadelphia could conceivably develop to become the top life sciences cluster in the world. Increased research collaboration between biotech and pharmaceutical firms, leveraging the pharmaceutical industry's knowledge of stewarding compounds through FDA clinical trials procedures, along with the excellent clinical trials management capabilities resident in the region, provide Greater Philadelphia a unique opportunity.

Methodology

The Overall Composite Index for Life Sciences was derived by the following formula:

Composite Index = f (0.45 * Current Impact) + (0.45 * Innovation Pipeline) + (0.1 * Small Business Vitality)

Current Impact: Therapeutics and Devices

Employment in metro areas
2007

Rank	Metro area	Number of workers
1	Greater New York	68,062
2	Greater Philadelphia	56,300
3	Greater Los Angeles	46,534
4	Boston	45,089
5	Greater San Francisco	37,466
6	Chicago	32,035
7	Minneapolis	24,071
8	San Diego	18,039
9	Washington, D.C.	17,183
10	Greater Raleigh-Durham	17,092
11	Seattle	13,283

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in metro areas
2007

Rank	Metro area	Location quotient
1	Greater Raleigh-Durham	3.8
2	Greater Philadelphia	3.2
3	Boston	3.0
4	San Diego	2.3
5	Minneapolis	2.2
6	Greater San Francisco	2.1
7	Greater New York	1.4
8	Seattle	1.3
9	Greater Los Angeles	1.3
10	Chicago	1.2
11	Washington, D.C.	1.1

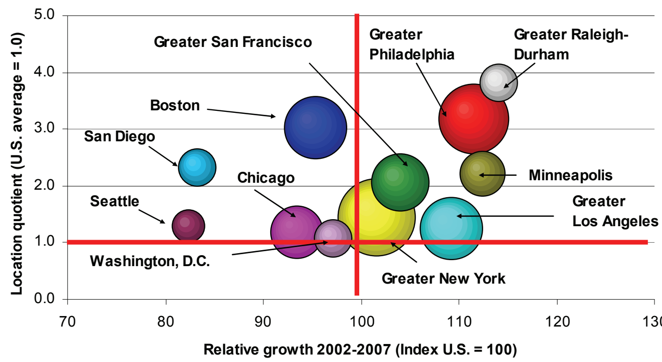
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Relative employment growth indexed to U.S.
2002-2007

Rank	Metro area	Relative growth index (US = 100)
1	Greater Raleigh-Durham	114
2	Minneapolis	112
3	Greater Philadelphia	112
4	Greater Los Angeles	109
5	Greater San Francisco	104
6	Greater New York	102
7	Washington, D.C.	97
8	Boston	95
9	Chicago	93
10	San Diego	83
11	Seattle	82

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Life sciences therapeutics and devices industry
Employment: concentration, growth, and size



Current Impact Measures (CIM) - scores
Ranked by composite index, 2007

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Philadelphia	83	83	98	50	73	83	82	100
2	Boston	66	80	84	84	100	71	64	99
3	Greater Raleigh-Durham	25	100	100	69	82	63	73	88
3	Greater New York	100	38	89	32	64	83	82	88
5	Greater San Francisco	55	54	91	45	82	100	100	86
6	Greater Los Angeles	68	33	96	28	73	100	100	82
7	Chicago	47	31	82	100	64	63	91	79
8	Minneapolis	35	58	99	61	64	56	91	77
9	San Diego	27	61	73	57	73	100	64	74
10	Washington, D.C.	25	28	85	47	82	45	91	62
11	Seattle	20	34	72	43	55	50	82	55

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Therapeutics and Devices in Philadelphia

Number of workers in therapeutics and devices industries by NAICS codes

Greater Philadelphia, 2007

Industry	NAICS codes	Bucks, PA	Burlington, NJ	Camden, NJ	Cecil, MD	Chester, PA	Delaware, PA	Gloucester, NJ	Mercer, NJ	Montgomery, PA	New Castle, DE	Philadelphia, PA	Salem, NJ	Total
Pharmaceuticals														
Pharmaceutical preparation manufacturing	325412	587	6	694	0	2,259	364	182	572	12,325	7,692	1,561	175	26,417
Pharmaceuticals industry aggregate		587	6	694	0	2,259	364	182	572	12,325	7,692	1,561	175	26,417
Biotechnology														
Medicinal and botanical manufacturing	325411	27	0	0	0	0	42	166	15	42	114	35	0	442
In-vitro diagnostic substance manufacturing	325413	165	0	0	0	447	45	9	0	0	1,145	0	0	1,811
Other biological product manufacturing	325414	57	0	0	0	1,303	8	0	0	42	0	40	0	1,449
Biotechnology industry aggregate		249	0	0	0	1,749	95	175	15	85	1,259	75	0	3,702
Medical devices														
Electromedical apparatus manufacturing	334510	175	42	0	0	74	42	0	26	67	0	0	0	426
Irradiation apparatus manufacturing	334517	0	0	0	0	0	0	0	0	89	0	64	0	153
Surgical and medical instrument manufacturing	339112	590	104	128	0	1,794	64	5	15	354	6	2	0	3,064
Surgical appliance and supplies manufacturing	339113	282	6	44	0	904	94	59	51	53	44	324	0	1,861
Dental equipment and supplies manufacturing	339114	43	6	70	0	25	5	0	0	54	6	99	0	308
Ophthalmic goods manufacturing	339115	7	36	62	0	25	32	32	0	0	6	48	0	248
Dental laboratories	339116	0	7	99	10	25	31	5	82	139	109	119	0	625
Medical devices aggregate		1,098	201	403	10	2,846	268	102	174	757	171	656	0	6,685
R&D in life sciences														
R&D in biotechnology	541711	238	34	0	0	838	58	0	6,197	11,578	0	553	0	19,496
R&D in life sciences industry aggregate		238	34	0	0	838	58	0	6,197	11,578	0	553	0	19,496
Therapeutics and devices aggregate		**2,172**	**241**	**1,097**	**10**	**7,692**	**785**	**459**	**6,958**	**24,745**	**9,122**	**2,845**	**175**	**56,300**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Therapeutics and devices employment location quotients by NAICS codes

Greater Philadelphia, 2007

Industry	NAICS codes	Bucks, PA	Burlington, NJ	Camden, NJ	Cecil, MD	Chester, PA	Delaware, PA	Gloucester, NJ	Mercer, NJ	Montgomery, PA	New Castle, DE	Philadelphia, PA	Salem, NJ	Total
Pharmaceuticals														
Pharmaceutical preparation manufacturing	325412	1.2	0.0	2.0	0.0	5.2	1.0	1.1	1.8	13.6	15.4	1.5	4.8	5.3
Pharmaceuticals industry aggregate		1.2	0.0	2.0	0.0	5.2	1.0	1.1	1.8	13.6	15.4	1.5	4.8	5.3
Biotechnology														
Medicinal and botanical manufacturing	325411	0.5	0.0	0.0	0.0	0.0	1.1	9.1	0.5	0.4	2.2	0.3	0.0	0.8
In-vitro diagnostic substance manufacturing	325413	4.4	0.0	0.0	0.0	13.1	1.6	0.7	0.0	0.0	29.3	0.0	0.0	4.6
Other biological product manufacturing	325414	1.1	0.0	0.0	0.0	27.1	0.2	0.0	0.0	0.4	0.0	0.3	0.0	2.6
Biotechnology industry aggregate		1.8	0.0	0.0	0.0	13.7	0.9	3.5	0.2	0.3	8.6	0.2	0.0	2.5
Medical devices														
Electromedical apparatus manufacturing	334510	1.4	0.5	0.0	0.0	0.6	0.4	0.0	0.3	0.3	0.0	0.0	0.0	0.3
Irradiation apparatus manufacturing	334517	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	1.1	0.0	0.6
Surgical and medical instrument manufacturing	339112	2.5	0.6	0.8	0.0	8.5	0.4	0.1	0.1	0.8	0.0	0.0	0.0	1.3
Surgical appliance and supplies manufacturing	339113	1.4	0.0	0.3	0.0	4.8	0.6	0.8	0.4	0.1	0.2	0.7	0.0	0.9
Dental equipment and supplies manufacturing	339114	1.3	0.3	2.9	0.0	0.8	0.2	0.0	0.0	0.9	0.2	1.4	0.0	0.9
Ophthalmic goods manufacturing	339115	0.1	0.8	1.3	0.0	0.4	0.7	1.4	0.0	0.0	0.1	0.3	0.0	0.4
Dental laboratories	339116	0.0	0.1	1.3	1.0	0.3	0.4	0.1	1.2	0.7	1.0	0.5	0.0	0.6
Medical devices aggregate		1.4	0.4	0.7	0.1	3.9	0.4	0.4	0.3	0.5	0.2	0.4	0.0	0.8
R&D in life sciences														
R&D in biotechnology	541711	0.8	0.2	0.0	0.0	3.2	0.3	0.0	32.7	21.6	0.0	0.9	0.0	6.5
R&D in life sciences industry aggregate		0.8	0.2	0.0	0.0	3.2	0.3	0.0	32.7	21.6	0.0	0.9	0.0	6.5
Therapeutics and devices aggregate		**1.3**	**0.2**	**0.9**	**0.1**	**5.0**	**0.6**	**0.8**	**6.2**	**7.7**	**5.2**	**0.8**	**1.3**	**3.2**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Pharmaceuticals Industry

Number of workers in pharmaceuticals industry
2007

Rank	Metro area	Number of workers
1	Greater New York	33,189
2	Greater Philadelphia	26,417
3	Chicago	16,274
4	Greater San Francisco	9,698
5	Greater Los Angeles	7,731
6	Greater Raleigh-Durham	4,678
7	Boston	3,375
8	Minneapolis	1,097
9	Seattle	525
10	San Diego	504
11	Washington, D.C.	320

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in pharmaceuticals industry
2007

Rank	Metro area	Location quotient
1	Greater Philadelphia	5.3
2	Greater Raleigh-Durham	3.7
3	Greater New York	2.5
4	Chicago	2.1
5	Greater San Francisco	1.9
6	Boston	0.8
7	Greater Los Angeles	0.7
8	Minneapolis	0.4
9	San Diego	0.2
10	Seattle	0.2
11	Washington, D.C.	0.1

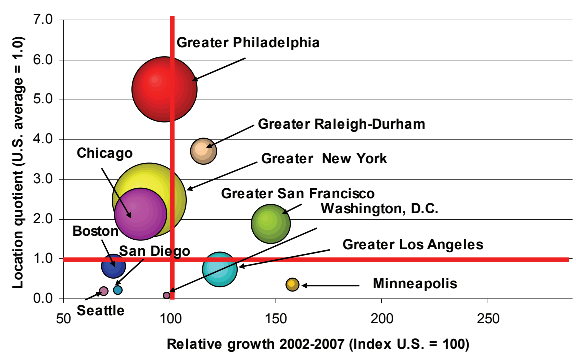
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Relative growth in pharmaceuticals industry
2002-2007

Rank	Metro area	Relative growth index (US = 100)
1	Minneapolis	158
2	Greater San Francisco	148
3	Greater Los Angeles	124
4	Greater Raleigh-Durham	116
5	Washington, D.C.	99
6	Greater Philadelphia	98
7	Greater New York	90
8	Chicago	86
9	San Diego	76
10	Boston	74
11	Seattle	69

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Pharmaceuticals industry
Employment: concentration, growth, and size



Current Impact Measures (CIM) scores for pharmaceuticals industry
Ranked by composite index, 2007

Rank	Metro area	Size and performance scores				Diversity scores			
		Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Philadelphia	80	100	62	92	100	100	50	100
2	Greater New York	100	47	57	79	100	100	50	91
3	Greater Raleigh-Durham	14	70	73	83	100	100	100	77
4	Greater San Francisco	29	36	93	58	50	100	100	67
5	Chicago	49	40	55	34	100	100	50	66
6	Greater Los Angeles	23	14	78	41	50	100	100	54
7	Boston	10	15	47	100	50	100	50	53
8	Minneapolis	3	7	100	32	50	50	100	43
9	San Diego	2	4	48	72	50	50	50	37
10	Washington, D.C.	1	1	62	36	50	50	50	33
11	Seattle	2	3	44	26	50	50	50	28

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Medical Devices

Number of workers in medical devices
2007

Rank	Metro area	Number of workers
1	Greater Los Angeles	26,568
2	Minneapolis	21,886
3	Greater San Francisco	16,173
4	Greater New York	15,225
5	Boston	13,214
6	Chicago	13,155
7	Greater Philadelphia	6,685
8	San Diego	6,078
9	Washington, D.C.	5,730
10	Seattle	3,031
11	Greater Raleigh-Durham	1,968

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in medical devices
2007

Rank	Metro area	Location quotient
1	Minneapolis	4.3
2	Greater San Francisco	1.9
3	Boston	1.9
4	San Diego	1.7
5	Greater Los Angeles	1.5
6	Chicago	1.0
7	Greater Raleigh-Durham	0.9
8	Greater Philadelphia	0.8
9	Washington, D.C.	0.8
10	Greater New York	0.7
11	Seattle	0.6

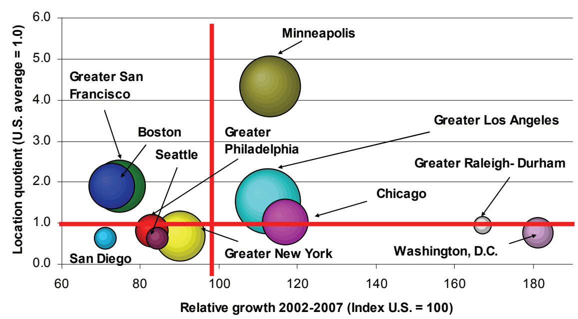
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Relative growth in medical devices
2002-2007

Rank	Metro area	Relative growth index (US = 100)
1	Washington, D.C.	181
2	Greater Raleigh-Durham	167
3	Chicago	117
4	Minneapolis	113
5	Greater Los Angeles	112
6	Greater New York	90
7	Seattle	84
8	Greater Philadelphia	83
9	Greater San Francisco	75
10	Boston	73
11	San Diego	71

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Medical devices industry
Employment: concentration, growth, and size



Current Impact Measures (CIM) scores for medical devices
Ranked by composite index, 2007

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Minneapolis	82	100	62	58	100	50	100	100
2	Greater Los Angeles	100	35	62	25	100	100	83	88
3	Chicago	50	24	64	100	75	50	100	75
4	Greater San Francisco	61	44	41	32	100	50	50	67
5	Boston	50	44	40	32	100	25	17	58
6	San Diego	23	39	39	33	50	100	67	54
7	Washington, D.C.	22	18	100	19	75	17	100	52
8	Greater New York	57	16	50	25	25	33	50	47
9	Greater Raleigh-Durham	7	22	92	26	25	20	50	39
10	Greater Philadelphia	25	19	46	27	25	33	67	38
11	Seattle	11	15	46	33	25	20	100	35

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Biotechnology

Number of workers in biotechnology
2007

Rank	Metro area	Number of workers
1	Greater New York	14,670
2	Greater Los Angeles	10,505
3	Greater Raleigh-Durham	6,559
4	Greater San Francisco	6,404
5	Boston	5,249
6	San Diego	3,975
7	Greater Philadelphia	3,702
8	Washington, D.C.	2,913
9	Seattle	780
10	Chicago	683
11	Minneapolis	666

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in biotechnology
2007

Rank	Metro area	Location quotient
1	Greater Raleigh-Durham	17.7
2	San Diego	6.2
3	Boston	4.3
4	Greater San Francisco	4.3
5	Greater New York	3.7
6	Greater Los Angeles	3.4
7	Greater Philadelphia	2.5
8	Washington, D.C.	2.2
9	Seattle	0.9
10	Minneapolis	0.7
11	Chicago	0.3

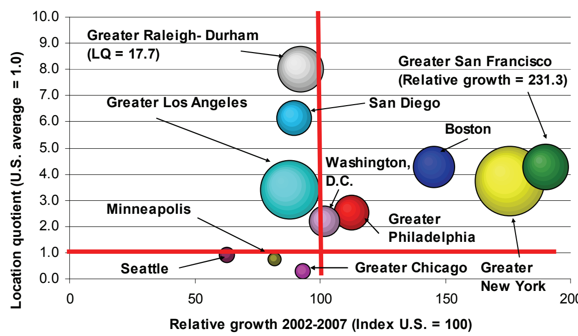
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Relative growth in biotechnology
2002-2007

Rank	Metro area	Relative growth index (US = 100)
1	Greater San Francisco	231
2	Greater New York	176
3	Boston	146
4	Greater Philadelphia	113
5	Washington, D.C.	102
6	Chicago	93
7	Greater Raleigh-Durham	92
8	San Diego	90
9	Greater Los Angeles	88
10	Minneapolis	82
11	Seattle	63

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Biotechnology industry
Employment: concentration, growth, and size



Current Impact Measures (CIM) scores for biotechnology
Ranked by composite index, 2007

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Greater Raleigh-Durham	45	100	40	55	100	100	25	100
2	Greater New York	100	21	76	22	75	100	75	98
3	Greater San Francisco	44	24	100	38	75	100	100	89
4	Boston	36	24	63	45	100	100	75	80
4	San Diego	27	35	39	100	75	100	25	80
6	Greater Los Angeles	72	19	38	21	50	100	50	72
7	Greater Philadelphia	25	14	49	30	75	100	50	61
8	Washington, D.C.	20	12	44	29	75	50	50	50
9	Chicago	5	2	40	42	25	33	50	33
9	Seattle	5	5	27	28	50	50	25	33
11	Minneapolis	5	4	35	30	25	33	25	28

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: R&D in the Life Sciences

Number of workers in R&D in the life sciences
2007

Rank	Metro area	Number of workers
1	Boston	23,251
2	Greater Philadelphia	19,496
3	Seattle	8,947
4	Washington, D.C.	8,220
5	San Diego	7,482
6	Greater San Francisco	5,191
7	Greater New York	4,978
8	Greater Raleigh-Durham	3,887
9	Chicago	1,923
10	Greater Los Angeles	1,730
11	Minneapolis	422

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in R&D in the life sciences
2007

Rank	Metro area	Location quotient
1	Boston	9.3
2	Greater Philadelphia	6.5
3	San Diego	5.7
4	Seattle	5.2
5	Greater Raleigh-Durham	5.2
6	Washington, D.C.	3.1
7	Greater San Francisco	1.7
8	Greater New York	0.6
9	Chicago	0.4
10	Greater Los Angeles	0.3
11	Minneapolis	0.2

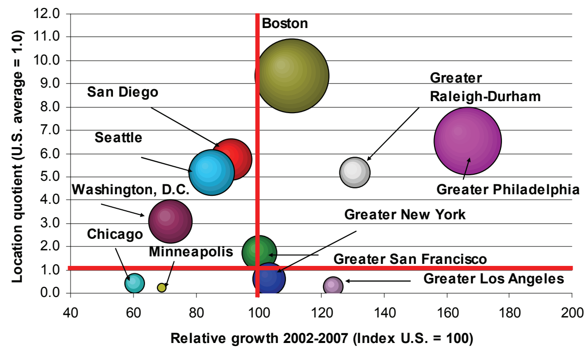
Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Relative growth in R&D in the life sciences
2002-2007

Rank	Metro area	Relative growth index (US = 100)
1	Greater Philadelphia	167
2	Greater Raleigh-Durham	131
3	Greater Los Angeles	124
4	Boston	111
5	Greater New York	103
6	Greater San Francisco	100
7	San Diego	91
8	Seattle	85
9	Washington, D.C.	72
10	Minneapolis	69
11	Chicago	61

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

R&D in the life sciences industry
Employment: concentration, growth, and size



Current Impact Measures (CIM) scores for R&D in the life sciences
Ranked by composite index, 2007

Rank	Metro area	Size and performance scores: Employment 2007	Location quotient 2007	Relative growth (U.S. = 100) 2002-2007	Establishments per 10,000 est. 2007	Diversity scores: Number of industries LQ >2 2007	Number of industries LQ <0.5 2007	Number of industries growing faster than U.S. 2002-2007	Composite index score 2007
1	Boston	100	100	66	100	100	100	100	100
2	Greater Philadelphia	84	70	100	39	100	100	100	85
3	Greater Raleigh-Durham	17	55	78	80	100	100	100	67
4	San Diego	32	61	55	38	100	100	50	60
5	Seattle	38	55	51	23	100	100	50	57
6	Washington, D.C.	35	33	43	56	100	100	50	56
7	Greater San Francisco	22	18	60	24	50	100	100	44
8	Greater New York	21	7	62	9	50	100	100	39
9	Greater Los Angeles	7	3	74	5	50	50	100	31
10	Chicago	8	5	36	18	50	50	50	25
11	Minneapolis	2	2	42	14	50	50	50	23

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Health-Care Services

Number of workers in health-care services
2007

Rank	Metro area	Number of workers
1	Greater New York	893,252
2	Greater Los Angeles	438,843
3	Chicago	371,241
4	Greater Philadelphia	283,026
5	Washington, D.C.	275,918
6	Boston	244,603
7	Greater San Francisco	216,998
8	Minneapolis	126,634
9	Seattle	124,392
10	San Diego	76,668
11	Greater Raleigh-Durham	54,075

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotients in health-care services
2007

Rank	Metro area	Location quotient
1	Greater New York	1.3
2	Washington, D.C.	1.2
3	Boston	1.2
4	Greater Philadelphia	1.1
5	Chicago	1.0
6	Seattle	0.9
6	Greater Raleigh-Durham	0.9
8	Greater San Francisco	0.8
8	Greater Los Angeles	0.8
8	Minneapolis	0.8
11	San Diego	0.7

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact Measures (CIM) scores for health-care services
Ranked by composite index, 2007

		Size and performance scores		Diversity scores		
Rank	Metro area	Employment 2007	Location quotient 2007	Number of industries LQ >1	Number of industries LQ <0.75	Composite index score
1	Greater New York	100	100	89	100	100
2	Greater Philadelphia	32	84	100	100	81
3	Washington, D.C.	31	91	74	33	68
4	Greater Los Angeles	49	62	79	40	61
5	Boston	27	87	53	29	61
6	Chicago	42	72	47	40	58
7	Seattle	14	64	68	25	50
8	Greater San Francisco	24	63	58	22	49
9	Greater Raleigh-Durham	6	64	47	22	44
10	Minneapolis	14	62	42	15	42
11	San Diego	9	52	37	18	36

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Life Science–Supporting Industries

Number of workers in LS–supporting industries
2007

Rank	Metro area	Number of workers
1	Greater New York	123,403
2	Greater Los Angeles	85,452
3	Chicago	63,741
4	Greater Philadelphia	60,187
5	Greater San Francisco	42,492
6	Boston	42,331
7	Minneapolis	39,186
8	Washington, D.C.	28,880
9	San Diego	18,236
10	Seattle	14,705
11	Greater Raleigh-Durham	13,755

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Location quotient in LS–supporting industries
2007

Rank	Metro area	Location quotient
1	Minneapolis	1.6
2	Greater Philadelphia	1.5
3	Greater Raleigh-Durham	1.4
4	Boston	1.3
5	Greater New York	1.2
6	Chicago	1.0
7	Greater San Francisco	1.0
8	San Diego	1.0
9	Greater Los Angeles	1.0
10	Washington, D.C.	0.8
11	Seattle	0.6

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact Measures (CIM) scores for life science–supporting industries
Ranked by composite index, 2007

		Size and performance scores		Diversity scores		
Rank	Metro area	Employment 2007	Location quotient 2007	Number of industries LQ >1	Number of industries LQ <0.75	Composite index score
1	Greater Philadelphia	49	94	100	100	100
2	Greater New York	100	72	44	33	76
3	Greater San Francisco	34	65	67	100	74
4	Minneapolis	32	100	33	25	71
5	Greater Los Angeles	69	64	56	33	67
6	Boston	34	79	56	33	67
7	Chicago	52	65	56	50	67
8	Greater Raleigh-Durham	11	85	56	20	63
9	San Diego	15	65	44	25	51
10	Washington, D.C.	23	50	22	13	39
11	Seattle	12	39	22	14	31

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Current Impact: Health-Care Services and Life Science–Supporting Industries in Philadelphia area

Number of workers in health-care services in Philadelphia
2007

Industry	NAICS codes	Bucks, PA	Burlington, NJ	Camden, NJ	Cecil, MD	Chester, PA	Delaware, PA	Gloucester, NJ	Mercer, NJ	Montgomery, PA	New Castle, DE	Philadelphia, PA	Salem, NJ	Total
Offices of physicians (except mental health specialists)	621111	4,897	3,366	4,341	247	3,394	4,731	1,479	3,282	8,001	5,079	11,176	137	50,130
Offices of physicians, mental health specialists	621112	129	266	157	8	49	45	93	243	201	59	456	10	1,716
Offices of dentists	621210	2,300	1,318	1,579	129	1,514	1,697	756	1,223	3,066	1,753	2,568	95	17,998
Offices of chiropractors	621310	399	191	236	14	240	237	97	124	482	289	352	10	2,671
Offices of optometrists	621320	167	127	156	25	139	192	167	200	350	181	239	17	1,960
Offices of mental health practitioners (except physicians)	621330	87	333	57	999	110	86	4,999	71	315	69	365	0	7,491
Offices of physical, occupational and speech therapists, and audiologists	621340	623	244	498	134	687	564	126	303	1,070	740	617	32	5,638
Offices of podiatrists	621391	128	67	154	0	106	190	67	74	199	87	253	0	1,325
Offices of all other miscellaneous health practitioners	621399	79	99	77	478	21	42	53	70	245	120	60	642	1,986
Family planning centers	621410	10	99	10	20	0	20	100	0	53	249	0	0	561
HMO medical centers	621491	249	0	0	0	15	0	0	0	22	499	579	0	1,364
Kidney dialysis centers	621492	220	0	118	20	473	132	249	10	300	249	668	0	2,439
Freestanding ambulatory surgical and emergency centers	621493	62	31	75	20	121	48	30	73	50	50	10	0	570
All other outpatient care centers	621498	252	171	353	150	88	259	192	55	351	1,228	668	0	3,767
Medical laboratories	621511	277	217	123	0	105	240	56	364	1,782	586	489	0	4,239
Diagnostic imaging centers	621512	55	106	109	0	36	237	225	87	84	426	346	0	1,711
Home health-care services	621610	1,179	1,374	1,438	0	817	2,153	92	947	4,209	1,741	3,894	0	17,844
Ambulance services	621910	667	154	357	0	460	485	86	122	740	99	874	0	4,044
Blood and organ banks	621991	0	0	0	0	0	0	0	20	0	120	0	0	140
All other miscellaneous ambulatory health-care services	621999	87	15	120	0	39	67	20	500	270	1,000	10	0	2,128
General medical and surgical hospitals	622110	8,363	4,675	11,381	0	4,780	0	0	8,073	14,078	11,034	44,178	0	106,562
Psychiatric and substance abuse hospitals	622210	0	10	47	0	189	0	0	0	1,442	1,386	1,548	0	4,622
Specialty (except psychiatric and substance abuse) hospitals	622310	10	99	674	0	570	0	0	100	204	1,943	2,431	0	6,031
Nursing care facilities	623110	3,195	3,360	2,844	473	2,133	3,769	744	2,403	7,211	2,144	7,813	0	36,089
Total		**23,435**	**16,322**	**24,904**	**2,717**	**16,086**	**15,194**	**9,631**	**18,344**	**44,725**	**31,131**	**79,594**	**943**	**283,026**

Number of workers in life science–supporting industries in Philadelphia
2007

Industry	NAICS codes	Bucks, PA	Burlington, NJ	Camden, NJ	Cecil, MD	Chester, PA	Delaware, PA	Gloucester, NJ	Mercer, NJ	Montgomery, PA	New Castle, DE	Philadelphia, PA	Salem, NJ	Total
Ophthalmic goods merchant wholesalers	42346	22	31	0	0	0	10	19	20	0	0	0	3	105
Druggists' goods merchant wholesalers	42421	177	225	0	0	702	1,070	804	790	2,785	977	244	0	7,774
Pharmacies and drugstores	44611	1,827	2,150	1,693	247	1,408	2,015	866	1,059	3,132	2,314	4,742	128	21,581
Optical goods stores	44613	137	87	363	0	160	143	66	139	284	116	291	0	1,786
All other basic inorganic chemical manufacturing	325188	319	8	60	0	99	72	19	0	1,332	356	0	0	2,265
All other basic organic chemical manufacturing	325199	99	0	0	249	265	387	221	53	659	2,696	7	10	4,646
Optical instrument and lens manufacturing	333314	142	100	0	0	53	6	0	222	127	0	25	0	675
Medical equipment and merchant wholesalers	423450	708	331	1,124	0	518	499	279	233	860	110	235	0	4,897
Direct health and medical insurance carriers	524114	43	563	250	0	109	107	10	90	1,320	1,721	6,923		11,136
Testing laboratories	541380	188	213	307	10	248	150	101	154	3,616	316	19	0	5,322
Total		**3,662**	**3,708**	**3,797**	**506**	**3,562**	**4,459**	**2,385**	**2,760**	**14,115**	**8,606**	**12,486**	**141**	**60,187**

Sources: U.S. Bureau of Labor Statistics, U.S. Census, Harris InfoSource, Milken Institute.

Innovation Pipeline: Life Sciences R&D

Industry R&D in life sciences

Rank	Metro area	U.S.$ millions, 2004	US$ per capita, 2004	Score
1	Greater Philadelphia	2,630.5	428.4	100
2	Greater New York	2,769.6	154.3	93
3	Boston	1,167.3	262.1	91
4	Greater San Francisco	1,300.4	221.2	90
5	Greater Raleigh-Durham	528.5	385.4	88
6	San Diego	662.3	225.4	85
7	Greater Los Angeles	1,229.2	90.1	83
8	Minneapolis	460.9	148.1	80
9	Seattle	411.2	129.8	78
10	Chicago	566.5	60.5	75
11	Washington DC	192.8	37.4	64

Academic R&D in life sciences

Rank	Metro area	U.S.$ thousands, 2006	U.S.$ per capita, 2006	Score
1	Greater Raleigh-Durham	1,069,738	700.4	100
2	Greater San Francisco	1,404,495	233.8	96
3	San Diego	798,943	268.6	94
4	Boston	808,205	180.3	92
5	Greater New York	1,462,060	81.1	91
6	Greater Philadelphia	828,984	133.8	91
7	Greater Los Angeles	1,160,929	84.9	90
8	Seattle	541,584	163.7	90
9	Chicago	916,590	96.2	90
10	Minneapolis	435,801	135.8	88
11	Washington, D.C.	350,466	66.0	83

NSF research funding to life sciences

Rank	Metro area	US$ millions, 2008	Per unit GMP, 2008	Score
1	Greater Raleigh-Durham	29.2	420.1	100
2	Boston	17.3	151.5	84
3	Washington, D.C.	20.9	87.8	80
4	Greater San Francisco	18.6	83.8	78
5	Greater Los Angeles	21.4	47.8	74
6	San Diego	11.5	82.9	73
7	Minneapolis	9.2	62.6	68
8	Greater Philadelphia	9.6	53.6	66
9	Greater New York	18.7	24.4	65
10	Seattle	7.4	50.7	63
11	Chicago	6.4	18.5	51

Number of STTR awards to life sciences firms

Rank	Metro area	2008	Per 1,000 businesses, 2008	Score
1	Boston	10	3.6	100
2	Greater Raleigh-Durham	4	6.8	95
3	Seattle	6	4.5	90
4	Greater San Francisco	7	3.3	88
5	Greater Philadelphia	7	3.1	87
6	Minneapolis	6	3.9	86
7	San Diego	4	3.3	70
8	Greater New York	8	1.4	69
9	Greater Los Angeles	7	1.4	63
10	Washington, D.C.	5	2.1	63
11	Chicago	5	1.7	59

STTR awards dollars to life sciences firms

Rank	Metro area	U.S.$ thousands, 2008	Per U.S.$ millions GMP, 2008	Score
1	Boston	3,392	29.7	100
2	Seattle	2,544	17.3	93
3	Greater Raleigh-Durham	1,567	22.6	91
4	Greater Philadelphia	2,511	14.0	91
5	Greater San Francisco	2,380	10.7	88
6	Minneapolis	1,373	9.3	82
7	Greater Los Angeles	2,249	5.0	81
8	San Diego	1,212	8.7	80
9	Washington, D.C.	1,485	6.2	79
10	Greater New York	2,381	3.1	77
11	Chicago	1,052	3.0	70

Number of SBIR awards to life sciences firms

Rank	Metro area	2008	Per 1,000 businesses, 2008	Score
1	Boston	142	50.0	100
2	Greater San Francisco	77	34.6	89
3	Seattle	49	39.7	85
4	Greater Raleigh-Durham	33	50.6	84
5	Greater Philadelphia	59	24.1	82
6	San Diego	39	34.8	81
7	Greater Los Angeles	73	14.7	79
8	Minneapolis	36	24.7	77
9	Washington, D.C.	37	17.5	73
10	Chicago	41	13.4	71
11	Greater New York	55	9.2	70

Innovation Pipeline: Life Sciences R&D

SBIR awards dollars to life sciences firms

Rank	Metro area	U.S.$ thousands, 2008	Per U.S.$ millions GMP, 2008	Score
1	Boston	49,622	435.1	100
2	Greater San Francisco	26,317	118.5	89
3	Greater Philadelphia	19,760	110.1	86
4	Seattle	16,558	112.8	86
5	Greater Raleigh-Durham	11,231	161.7	85
6	Greater Los Angeles	24,876	55.4	84
7	San Diego	13,405	96.5	83
8	Minneapolis	12,683	86.2	82
9	Washington, D.C.	11,901	49.9	79
10	Chicago	13,477	38.9	78
11	Greater New York	18,766	24.5	77

Competitive NSF funding rate in life sciences

Rank	Metro area	Number of awards, 2008	Funding rate(%), 2008	Score
1	Boston	46	27.2%	100
2	Greater Raleigh-Durham	38	26.0%	91
3	Chicago	36	20.5%	79
4	Greater Los Angeles	28	25.5%	78
5	Greater San Francisco	31	20.9%	74
6	Seattle	19	26.4%	64
7	San Diego	17	27.0%	60
8	Washington, D.C.	22	19.5%	58
9	Greater New York	20	20.6%	56
10	Minneapolis	14	21.5%	44
11	Greater Philadelphia	14	13.6%	25

NIH funding

Rank	Metro area	U.S.$ millions, 2007	U.S.$ per capita, 2007	Score
1	Boston	$2,086	465.4	100
2	Washington, D.C.	$668	125.9	82
3	Greater Raleigh-Durham	$273	178.9	78
4	Seattle	$356	107.5	77
5	San Diego	$310	104.2	75
6	Greater San Francisco	$440	73.3	75
7	Greater New York	$746	41.4	75
8	Greater Philadelphia	$419	67.6	74
9	Minneapolis	$259	80.8	72
10	Greater Los Angeles	$352	25.8	66
11	Chicago	$245	25.7	63

Life Sciences R&D Composite Index

Rank	Metro area	Composite score	Rebased composite score
1	Boston	866.2	100.0
2	Greater Raleigh-Durham	811.8	93.7
3	Greater San Francisco	767.3	88.6
4	Seattle	724.3	83.6
5	Greater Philadelphia	703.3	81.2
6	San Diego	702.6	81.1
7	Greater Los Angeles	697.0	80.5
8	Minneapolis	678.3	78.3
9	Greater New York	673.4	77.7
10	Washington, D.C.	660.3	76.2
11	Chicago	636.2	73.4

Innovation Pipeline: Risk Capital and Entrepreneurial Infrastructure

Life sciences VC investment

Rank	Metro area	2008, U.S.$ millions	Per $100,000 GMP, 2008	Score
1	Greater Philadelphia	1,979	1103.05	100
2	Boston	1,133	993.35	95
3	San Diego	593	426.82	85
4	Greater San Francisco	592	266.24	82
5	Greater Raleigh-Durham	257	369.53	79
6	Minneapolis	276	187.26	74
7	Seattle	269	183.44	74
8	Greater New York	516	67.40	72
9	Washington, D.C.	216	90.69	68
10	Chicago	112	32.39	56
11	Greater Los Angeles	85	18.87	51

Life sciences VC investment growth

Rank	Metro area	Annual absolute growth, 2003-2008 (U.S.$ millions)	Relative growth, 2003-2008	Score
1	Greater San Francisco	374.3	177.39	100
2	Seattle	160.6	158.73	91
3	San Diego	198.2	104.49	90
4	Minneapolis	139.7	136.91	89
5	Greater New York	128.9	91.80	84
6	Boston	118.7	77.72	82
7	Greater Philadelphia	71.5	108.84	81
8	Greater Los Angeles	42.0	124.95	77
9	Greater Raleigh-Durham	53.1	89.40	76
10	Washington, D.C.	39.8	85.44	73
11	Chicago	9.4	76.81	59

Life sciences companies receiving VC investment

Rank	Metro area	Number, 2008	Per 100,000 life science businesses, 2008	Score
1	Greater San Francisco	128	2,376	100
2	San Diego	49	5,137	99
3	Boston	62	3,977	98
4	Seattle	22	2,668	87
5	Greater Raleigh-Durham	19	2,765	86
6	Minneapolis	18	1,639	82
7	Greater Philadelphia	23	1,108	80
8	Greater New York	25	774	78
9	Washington, D.C.	5	2,245	75
10	Greater Los Angeles	25	222	68
11	Chicago	9	359	64

Growth in life sciences companies receiving VC investments

Rank	Metro area	Absolute growth, 2003-2008	Relative growth, 2003-2008	Score
1	Greater San Francisco	24	159.76	100
2	Seattle	13	144.70	93
3	Greater New York	14	119.61	93
4	Boston	18	93.62	92
5	Greater Philadelphia	10	129.21	91
6	Greater Los Angeles	5	165.55	87
7	Washington, D.C.	1	78.75	62
8	Chicago	0	77.26	2
9	San Diego	0	76.50	1
10	Minneapolis	-1	75.17	1
11	Greater Raleigh-Durham	-3	65.50	0

Academic degrees awarded in entrepreneurship

Rank	Metro area	2007	Per million people of 25-34 age cohort, 2007	Score
1	Chicago	116	88.09	100
2	Seattle	43	91.91	96
3	Boston	46	79.93	96
4	Minneapolis	22	49.90	90
5	Greater Philadelphia	15	20.23	85
6	Washington, D.C.	9	12.25	80
7	Greater New York	16	6.85	80
8	Greater San Francisco	4	4.96	73
9	Greater Los Angeles	3	1.58	67
10	Greater Raleigh-Durham	0	0.00	0
10	San Diego	0	0.00	0

Tech Fast 500 companies in life sciences

Rank	Metro area	Number, 2007	Per 100,000 life science businesses, 2007	Score
1	Greater San Francisco	25	1123	100
2	San Diego	7	622	92
3	Greater Philadelphia	6	247	88
4	Greater Los Angeles	8	161	87
5	Greater Raleigh-Durham	2	307	84
6	Boston	3	106	81
7	Minneapolis	1	68	75
8	Greater New York	2	34	75
9	Chicago	0	0	0
9	Washington, D.C.	0	0	0
9	Seattle	0	0	0

Business starts in life sciences

Rank	Metro area	Total number, 2008	Per 100,000 life science businesses, 2008	Score
1	Greater New York	12	201.95	100
2	Greater Los Angeles	9	181.34	98
3	San Diego	4	354.30	98
4	Boston	6	211.19	97
5	Washington, D.C.	4	187.09	95
6	Seattle	3	242.52	94
7	Greater San Francisco	4	179.29	94
8	Greater Philadelphia	4	164.14	94
9	Chicago	3	97.82	90
10	Minneapolis	2	136.61	90
11	Greater Raleigh-Durham	0	0.00	0

Life Sciences Risk Capital Composite Index

Rank	Metro area	Composite score	Rebased composite score
1	Boston	94.0	100.0
2	Greater San Francisco	92.0	97.8
3	Greater Philadelphia	89.1	94.8
4	Greater New York	79.5	84.6
5	Seattle	78.3	83.3
6	San Diego	77.6	82.5
7	Minneapolis	74.4	79.1
8	Greater Los Angeles	68.9	73.3
9	Washington, D.C.	67.5	71.8
10	Greater Raleigh-Durham	62.3	66.2
11	Chicago	56.2	59.8

Innovation Pipeline: Human Capital

Life sciences bachelor's degrees awarded

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Greater Philadelphia	3,087	41.41	100
2	Greater Raleigh-Durham	1,512	67.95	98
3	Greater Los Angeles	4,156	21.48	97
4	Greater New York	4,418	18.69	96
5	Greater San Francisco	2,275	27.74	94
6	San Diego	1,630	37.64	94
7	Boston	1,602	27.70	91
8	Washington, D.C.	1,628	22.10	89
9	Seattle	1,292	27.69	89
10	Chicago	2,115	15.99	89
11	Minneapolis	1,049	24.06	86

Life sciences graduate students

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Boston	7,556	130.66	100
2	Greater Raleigh-Durham	3,701	166.31	97
3	Greater Philadelphia	6,300	84.52	96
4	Greater New York	10,345	43.75	94
5	Greater San Francisco	5,088	62.04	92
6	Chicago	6,104	46.14	91
7	Minneapolis	3,376	77.45	90
8	Greater Los Angeles	6,774	35.02	90
9	Seattle	2,726	58.43	87
10	San Diego	2,036	47.01	83
11	Washington, D.C.	1,122	15.23	71

Life sciences master's degrees awarded

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Boston	1,562	27.01	100
2	Greater New York	2,942	12.44	99
3	Greater Philadelphia	1,419	19.04	96
4	Greater Raleigh-Durham	743	33.39	95
5	Washington, D.C.	1,020	13.85	90
6	Greater San Francisco	995	12.13	88
7	Chicago	1,178	8.90	87
8	Greater Los Angeles	1,326	6.85	86
9	Minneapolis	540	12.39	83
10	Seattle	508	10.89	81
11	San Diego	377	8.70	76

Life sciences Ph.D.s awarded

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Boston	783	13.54	100
2	Greater Raleigh-Durham	376	16.90	94
3	Greater Philadelphia	571	7.66	90
4	Greater New York	795	3.36	85
5	Greater San Francisco	390	4.76	81
6	Chicago	483	3.65	81
7	Greater Los Angeles	529	2.73	79
8	Minneapolis	221	5.07	76
9	Seattle	227	4.87	76
10	San Diego	158	3.65	69
11	Washington, D.C.	180	2.44	66

Medical Doctor (M.D.) degrees awarded

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Greater Philadelphia	1,571	21.08	100
2	Greater New York	2,156	9.12	95
3	Boston	1,000	17.29	94
4	Chicago	1,250	9.45	90
5	Greater Raleigh-Durham	446	20.04	87
6	Minneapolis	523	12.00	84
7	Washington, D.C.	578	7.85	81
8	Greater San Francisco	510	6.22	77
9	Greater Los Angeles	773	4.00	77
10	Seattle	337	7.22	75
11	San Diego	186	4.29	64

Life sciences postdocs

Rank	Metro area	Number, 2006	Per 10,000 people of 25-34 age cohort, 2006	Score
1	Boston	5,014	86.71	100
2	Greater Philadelphia	1,771	23.76	82
3	Greater San Francisco	1,673	20.40	80
4	Greater Raleigh-Durham	823	36.98	80
5	Greater Los Angeles	1,998	10.33	77
6	Greater New York	2,036	8.61	75
7	Seattle	850	18.22	74
8	San Diego	723	16.69	72
9	Minneapolis	502	11.52	67
10	Chicago	783	5.92	65
11	Washington, D.C.	35	0.48	22

Number of life sciences Ph.D.–granting institutions

Rank	Metro area	Number, 2006	Per 100,000 people of 25-34 age cohort, 2006	Score
1	Boston	23	3.98	100
2	Greater Philadelphia	20	2.68	88
3	Washington, D.C.	19	2.58	86
4	Greater New York	34	1.44	86
5	Greater Raleigh-Durham	10	4.49	84
6	Chicago	21	1.59	78
7	Greater San Francisco	12	1.46	63
8	San Diego	8	1.85	60
9	Greater Los Angeles	13	0.67	48
10	Minneapolis	6	1.38	47
11	Seattle	4	0.86	27

Recent years' bachelor's degrees awarded in life sciences

Rank	Metro area	Number, 2002 - 2006	Per 10,000 civilian workers, 2006	Score
1	Greater Philadelphia	12,683	556.13	100
2	Greater New York	17,015	169.03	94
3	Greater Raleigh-Durham	6,993	268.50	92
4	Greater San Francisco	10,105	104.39	88
5	Greater Los Angeles	18,094	44.06	86
6	Boston	9,218	55.87	83
7	San Diego	7,064	54.13	82
8	Seattle	5,970	43.82	79
9	Chicago	9,456	25.19	79
10	Washington, D.C.	7,189	31.78	78
11	Minneapolis	4,459	25.20	74

Recent years' master's degrees awarded in life sciences

Rank	Metro area	Number, 2002 - 2006	Per 10,000 civilian workers, 2006	Score
1	Greater Philadelphia	6,880	301.67	100
2	Greater New York	13,197	131.10	99
3	Greater Raleigh-Durham	3,430	131.70	90
4	Boston	8,510	51.58	89
5	Greater San Francisco	4,418	45.64	84
6	Greater Los Angeles	6,197	15.09	79
7	Chicago	5,382	14.34	77
8	Washington, D.C.	4,153	18.36	77
9	Seattle	2,291	16.82	73
10	Minneapolis	2,323	13.13	71
11	San Diego	1,612	12.35	68

Recent years' Ph.D. degrees awarded in life sciences

Rank	Metro area	Number, 2002 - 2006	Per 10,000 civilian workers, 2006	Score
1	Greater Philadelphia	2,007	88.00	100
2	Greater Raleigh-Durham	1,751	67.23	97
3	Greater New York	2,667	26.49	92
4	Boston	3,280	19.88	92
5	Greater San Francisco	1,801	18.61	86
6	Greater Los Angeles	2,338	5.69	79
7	Chicago	2,141	5.70	78
8	Seattle	832	6.11	71
9	Minneapolis	919	5.19	70
10	San Diego	662	5.07	67
11	Washington, D.C.	755	3.34	65

Recent years' Medical Doctor (M.D.) degrees awarded

Rank	Metro area	Number, 2002 - 2006	Per 10,000 civilian workers, 2006	Score
1	Greater Philadelphia	7,726	338.77	100
2	Greater New York	9,894	98.29	93
3	Greater Raleigh-Durham	2,546	97.75	84
4	Boston	5,614	34.03	82
5	Chicago	6,114	16.29	78
6	Greater San Francisco	2,507	25.90	75
7	Greater Los Angeles	4,205	10.24	72
8	Washington, D.C.	2,813	12.43	71
9	Minneapolis	2,476	14.00	71
10	Seattle	1,604	11.77	67
11	San Diego	592	4.54	53

Life Sciences Human Capital Composite Index

Rank	Metro area	Composite score	Rebased composite score
1	Greater Philadelphia	1052.0	100.0
2	Boston	1031.5	98.1
3	Greater New York	1009.6	96.0
4	Greater Raleigh-Durham	997.2	94.8
5	Greater San Francisco	909.6	86.5
6	Chicago	891.6	84.8
7	Greater Los Angeles	868.1	82.5
8	Minneapolis	818.1	77.8
9	Seattle	798.0	75.9
10	Washington, D.C.	795.1	75.6
11	San Diego	787.9	74.9

Innovation Pipeline: Life Sciences Workforce

Intensity of medical and health services managers

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater New York	14,500	96.3	100
2	Greater Philadelphia	5,420	87.7	92
3	Boston	4,640	92.2	92
4	Greater Los Angeles	6,630	50.0	90
5	Minneapolis	3,490	65.7	87
6	Chicago	4,890	43.0	87
7	Washington, D.C.	3,010	44.0	83
8	Greater San Francisco	2,560	45.4	82
9	San Diego	2,010	51.1	82
10	Greater Raleigh-Durham	1,270	55.7	79
11	Seattle	1,370	32.5	76

Intensity of biomedical engineers

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Boston	1,000	19.9	100
2	Greater San Francisco	980	17.4	98
3	Greater Philadelphia	730	11.8	92
4	Minneapolis	630	11.9	90
5	Seattle	430	10.2	85
6	Greater Raleigh-Durham	310	13.6	84
7	San Diego	370	9.4	82
8	Greater Los Angeles	440	3.3	74
9	Washington, D.C.	290	4.2	72
10	Greater New York	350	2.3	68
NA	Chicago	0	0.0	NA

Intensity of chemical engineers

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Boston	800	15.9	100
2	Greater Philadelphia	510	8.3	88
3	Washington, D.C.	470	6.9	85
4	Seattle	330	7.8	83
5	Minneapolis	330	6.2	81
6	Chicago	440	3.9	79
7	Greater Raleigh-Durham	170	7.5	76
8	Greater New York	410	2.7	74
9	Greater Los Angeles	370	2.8	73
10	San Diego	160	4.1	69
11	Greater San Francisco	160	2.8	65

Intensity of material engineers

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater San Francisco	750	13.3	100
2	Seattle	400	9.5	89
3	Greater Philadelphia	410	6.6	86
4	Greater Los Angeles	530	4.0	83
5	Washington, D.C.	320	4.7	79
6	San Diego	230	5.9	78
7	Boston	240	4.8	76
8	Chicago	260	2.3	69
9	Minneapolis	160	3.0	67
10	Greater Raleigh-Durham	90	3.9	64
NA	Greater New York	0	0.0	NA

Intensity of electro-mechanical technicians

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater San Francisco	1,000	17.8	100
2	Washington, D.C.	570	8.3	87
3	Chicago	620	5.5	83
4	Boston	360	7.2	80
5	Greater Los Angeles	450	3.4	75
6	Minneapolis	220	4.1	70
7	Greater New York	140	0.9	50
8	Greater Philadelphia	60	1.0	42
9	Seattle	40	0.9	37
NA	Greater Raleigh-Durham	0	0.0	NA
NA	San Diego	0	0.0	NA

Intensity of biochemists and biophysicists

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Boston	1,810	36.0	100
2	Greater Philadelphia	1,470	23.8	94
3	San Diego	990	25.2	91
4	Greater Raleigh-Durham	670	29.4	89
5	Greater San Francisco	1,030	18.3	89
6	Seattle	330	7.8	71
7	Greater New York	550	3.7	69
8	Washington, D.C.	310	4.5	65
9	Minneapolis	120	2.3	51
NA	Chicago	0	0.0	NA
NA	Greater Los Angeles	0	0.0	NA

Intensity of microbiologists

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Boston	780	15.5	100
2	San Diego	390	9.9	88
3	Greater Philadelphia	400	6.5	84
4	Washington, D.C.	420	6.1	84
5	Greater New York	620	4.1	83
6	Seattle	240	5.7	77
7	Chicago	360	3.2	75
8	Greater Raleigh-Durham	160	7.0	75
9	Minneapolis	240	4.5	74
10	Greater Los Angeles	340	2.6	72
11	Greater San Francisco	210	3.7	71

Intensity of medical scientists, except epidemiologists

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater San Francisco	5,830	103.5	100
2	Greater Philadelphia	5,250	85.0	98
3	Boston	4,650	92.4	97
4	San Diego	3,520	89.6	95
5	Seattle	3,200	75.9	93
6	Greater Los Angeles	3,570	26.9	86
7	Minneapolis	1,440	27.1	79
8	Greater New York	2,340	15.5	79
9	Washington, D.C.	820	12.0	69
10	Greater Raleigh-Durham	370	16.2	65
11	Chicago	650	5.7	62

Intensity of chemists

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater Raleigh-Durham	1,800	78.9	100
2	Greater Philadelphia	2,930	47.4	100
3	Greater San Francisco	2,270	40.3	96
4	Boston	2,030	40.3	95
5	Greater New York	2,840	18.9	92
6	San Diego	1,430	36.4	92
7	Minneapolis	1,490	28.0	90
8	Washington, D.C.	1,380	20.2	86
9	Greater Los Angeles	1,910	14.4	86
10	Chicago	1,720	15.1	86
11	Seattle	730	17.3	80

Intensity of material scientists

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Chicago	600	5.3	100
2	Greater Philadelphia	280	4.5	89
3	Boston	230	4.6	86
4	San Diego	190	4.8	85
5	Greater San Francisco	200	3.6	81
6	Greater New York	280	1.9	78
7	Washington, D.C.	80	1.2	56
8	Greater Los Angeles	110	0.8	56
9	Seattle	50	1.2	51
NA	Minneapolis	0	0.0	NA
NA	Greater Raleigh-Durham	0	0.0	NA

Intensity of biological technicians

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Boston	4,680	93.0	100
2	Greater Raleigh-Durham	2,520	110.5	97
3	Greater San Francisco	2,880	51.1	92
4	San Diego	1,770	45.0	87
5	Greater Philadelphia	2,130	34.5	86
6	Seattle	1,710	40.6	86
7	Greater New York	2,790	18.5	84
8	Greater Los Angeles	2,020	15.2	80
9	Chicago	1,060	9.3	71
10	Washington, D.C.	560	8.2	65
11	Minneapolis	380	7.2	61

Intensity of chemical technicians

Rank	Metro area	Number, 2007	Per 100,000 workers, 2007	Score
1	Greater Philadelphia	2,480	40.1	100
2	Boston	1,020	20.3	86
3	Greater Los Angeles	1,640	12.4	86
4	Greater San Francisco	1,040	18.5	86
5	San Diego	740	18.8	83
6	Greater New York	1,370	9.1	82
7	Greater Raleigh-Durham	490	21.5	80
8	Minneapolis	660	12.4	78
9	Chicago	880	7.7	77
10	Seattle	240	5.7	63
NA	Washington, D.C.	0	0.0	NA

Intensity of sales representatives, wholesale and manufacturing, technical and scientific products

Rank	Metro area		Per 100,000 workers, 2007	Score
1	Boston	11,460	227.7	100
2	Greater San Francisco	11,580	205.6	99
3	Chicago	15,720	138.2	99
4	Seattle	7,750	183.9	96
5	Greater Philadelphia	7,530	121.8	93
6	Greater Los Angeles	10,810	81.5	93
7	Greater New York	11,270	74.8	92
8	Greater Raleigh-Durham	4,230	185.5	92
9	Minneapolis	6,430	121.0	92
10	Washington, D.C.	5,360	78.3	88
11	San Diego	3,730	94.9	86

Life Sciences Workforce Composite Index

Rank	Metro area	Composite score	Rebased composite score
1	Greater San Francisco	96.7	100.0
2	Boston	93.4	96.6
3	Greater Philadelphia	87.9	91.0
4	San Diego	84.8	87.7
5	Greater Raleigh-Durham	81.9	84.7
6	Chicago	80.6	83.4
7	Greater Los Angeles	79.5	82.2
8	Greater New York	79.2	81.9
9	Minneapolis	76.6	79.3
10	Washington, D.C.	76.6	79.3
11	Seattle	75.8	78.5

Innovation Pipeline: Innovation Output

Patents issued

Rank	Metro area	Patents issued	Per 1,000 life science workers, 2007	Score
1	Boston	345	10.2	100
2	Greater Los Angeles	247	8.6	94
3	Greater San Francisco	215	7.1	90
4	Greater New York	218	5.8	87
5	Greater Raleigh-Durham	111	9.2	85
6	San Diego	91	5.9	77
7	Chicago	108	4.0	74
8	Greater Philadelphia	88	3.0	68
9	Washington, D.C.	51	3.8	64
10	Minneapolis	44	2.8	59
11	Seattle	43	2.6	58

Patents filed

Rank	Metro area	Patents Filed	Per 1,000 life science workers, 2007	Score
1	Boston	996.0	29.6	100
2	Greater Los Angeles	601.0	20.9	92
3	Greater Philadelphia	593.0	20.0	91
4	Greater New York	581.0	15.5	88
5	Greater Raleigh-Durham	290.0	24.0	86
6	Chicago	371.0	13.6	83
7	Washington, D.C.	208.0	15.3	78
8	Greater San Francisco	293.0	9.6	77
9	Seattle	88.0	5.2	60
10	Minneapolis	53.0	3.4	50
11	San Diego	25.0	1.6	36

Clinical trials (Phase I)

Rank	Metro area	2005-2007	Per 100,000 people, 2007	Score
1	Greater Philadelphia	169	2.7	100
2	Boston	127	2.8	96
3	Washington, D.C.	114	2.1	89
4	Greater Raleigh-Durham	60	3.9	89
5	Seattle	84	2.5	87
6	Greater New York	167	0.9	82
7	Greater San Francisco	96	1.6	82
8	Chicago	90	0.9	72
9	San Diego	49	1.6	71
10	Minneapolis	50	1.6	71
11	Greater Los Angeles	91	0.7	67

Clinical trials (Phase II)

Rank	Metro area	As of 2009	Per 100,000 people, 2004	Score
1	Greater Raleigh-Durham	354	23.2	100
2	Greater Philadelphia	604	9.8	96
3	Seattle	434	13.1	96
4	Boston	499	11.1	96
5	Washington, D.C.	441	8.3	91
6	Chicago	581	6.1	91
7	Greater New York	649	3.6	86
8	Greater San Francisco	363	6.0	85
9	Minneapolis	232	7.2	82
10	San Diego	185	6.2	78
11	Greater Los Angeles	343	2.5	75

Clinical trials (Phase III)

Rank	Metro area	As of 2009	Per 100,000 people, 2004	Score
1	Greater Raleigh-Durham	479	31.4	100
2	Seattle	661	20.0	99
3	Greater Philadelphia	824	13.3	97
4	Boston	566	12.6	92
5	Washington, D.C.	604	11.4	92
6	Chicago	742	7.8	90
7	Greater New York	858	4.8	86
8	Minneapolis	302	9.4	83
9	Greater San Francisco	368	6.1	80
10	San Diego	187	6.3	74
11	Greater Los Angeles	348	2.5	71

Clinical trials (Phase IV)

Rank	Metro area	2005-2007	Per 100,000 people, 2007	Score
1	Greater Raleigh-Durham	132.2	8.7	100
2	Boston	217.5	4.9	99
3	Greater Philadelphia	243.3	3.9	97
4	Seattle	156.9	4.7	94
5	Washington, D.C.	161.0	3.0	88
6	Greater New York	283.2	1.6	87
7	Chicago	197.6	2.1	85
8	Greater San Francisco	132.1	2.2	81
9	Minneapolis	85.1	2.7	77
10	San Diego	67.3	2.3	71
11	Greater Los Angeles	124.9	0.9	67

University R&D expenditures

Rank	Metro area	R&D expenditures	Per life science worker, 2007	Score
1	Boston	$4,360,288,989	129,385	100
2	Greater Raleigh-Durham	$1,682,809,586	139,305	97
3	Greater New York	$2,613,208,754	69,760	97
4	Chicago	$1,479,899,971	54,408	94
5	Greater Philadelphia	$1,418,567,790	47,925	94
6	Seattle	$961,483,207	57,163	93
7	Washington, D.C.	$771,078,026	56,739	92
8	Greater San Francisco	$951,605,798	31,210	91
9	Greater Los Angeles	$874,077,846	30,329	91
10	Minneapolis	$547,966,000	35,149	90
11	San Diego	$80,907,000	5,210	79

University startups

Rank	Metro area	Startups, 2007	Per 100,000 life science workers	Score
1	Boston	60.0	178.0	100
2	Greater New York	33.0	88.1	86
3	Chicago	18.0	66.2	76
4	Greater Raleigh-Durham	10.0	82.8	72
5	Seattle	11.0	65.4	71
6	Greater Los Angeles	13.0	45.1	69
7	Greater Philadelphia	12.0	40.5	67
8	Washington, D.C.	7.0	51.5	63
9	Greater San Francisco	7.0	23.0	55
10	Minneapolis	4.0	25.7	50
11	San Diego	1.0	6.4	20

University licensing income received

Rank	Metro area	Licensing income received, 2007	Per life science worker	Score
1	Greater New York	$966,175,791	25792.2	100
2	Boston	$504,221,631	14962.1	96
3	Greater San Francisco	$168,991,030	5542.5	89
4	Chicago	$108,439,938	3986.8	87
5	Minneapolis	$63,315,910	4061.3	85
6	Seattle	$63,283,697	3762.4	85
7	Greater Philadelphia	$25,928,434	876.0	77
8	Greater Raleigh-Durham	$9,095,355	752.9	73
9	Greater Los Angeles	$11,720,663	406.7	72
10	Washington, D.C.	$1,741,245	128.1	62
11	San Diego	$695,000	44.8	56

University licenses/options executed

Rank	Metro area	Licenses/options executed	Per 1,000 life science workers, 2007	Score
1	Boston	526.0	15.6	100
2	Greater Raleigh-Durham	283.0	23.4	98
3	Seattle	203.0	12.1	87
4	Greater New York	205.0	5.5	78
5	Chicago	115.0	4.2	69
6	Washington, D.C.	78.0	5.7	68
7	Minneapolis	76.0	4.9	66
8	Greater Philadelphia	102.0	3.4	65
9	Greater San Francisco	100.0	3.3	64
10	Greater Los Angeles	82.0	2.8	60
11	San Diego	19.0	1.2	35

FDA new medical devices premarket approval

Rank	Metro area	Premarket approvals, 2007	Per million people, 2007	Score
1	Minneapolis	292.0	91.0	100
2	Greater Los Angeles	235.0	17.2	82
3	Greater San Francisco	94.0	15.6	72
4	Boston	27.0	6.0	50
5	Greater Raleigh-Durham	13.0	8.5	46
6	Greater Philadelphia	22.0	3.6	43
7	San Diego	14.0	4.7	41
8	Chicago	9.0	0.9	21
9	Washington, D.C.	4.0	0.8	11
10	Greater New York	5.0	0.3	3
11	Seattle	2.0	0.6	2

Life Sciences Innovation Output Composite Index

Rank	Metro area	Composite score	Rebased composite score
1	Boston	81	100.0
2	Greater Raleigh-Durham	75	92.8
3	Greater San Francisco	72	88.0
4	Greater Philadelphia	70	86.7
5	Greater Los Angeles	70	85.6
6	Minneapolis	68	83.8
7	Greater New York	66	81.3
8	Chicago	64	79.3
9	Seattle	62	75.7
10	Washington, D.C.	61	74.7
11	San Diego	54	66.9

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